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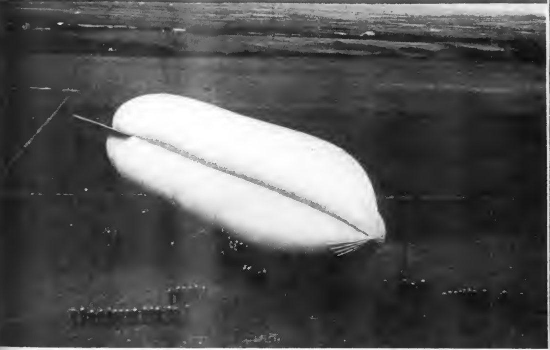

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7

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SPECIAL FEATURES

TESTING MODEL PROPELLERS AT N. P. L.
DESCRIPTION OF THE ALBATROS BIPLANE
FINISHING AIRPLANE PROPELLERS
FUTURE OF COMMERCIAL AERONAUTICS
INTERNATIONAL AIRCRAFT STANDARDS

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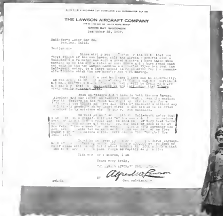

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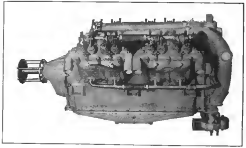

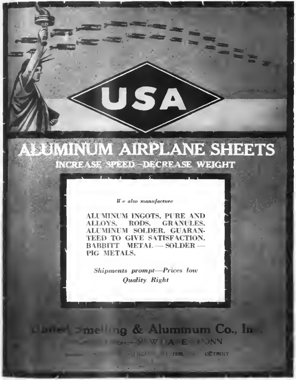
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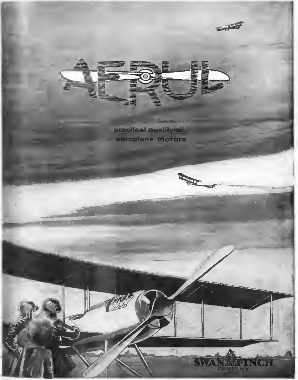
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Vol III November 1, 1917 No. 7

Whirling Table and Method of Testing Model Airscrews at N. P. L.

By A. Fage, A.R.C.Sc., D.I.C.

At the present time there are two different methods of testing airscrews at the National Physical Laboratory, (a) with an airscrew dynamometer mounted on a whirling table and, (b) with an airscrew balance designed for use in a wind channel.

The present article deals only with the first of these methods, but the author hopes to obtain permission to publish, in the near future, a description of the airscrew balance

Description of the Whirling Table and the Airscrew Dynamometer

A brief description of the whirling table as first designed is given in the "Technical Report of the Advisory Committee for Aeronautics, Year 1909 10," but since that time both the dynamometer and the method of experimenting have been considerably modified and improved *

The whirling table, a photograph of which is given in Fig 1, is housed in a galvanized iron shed, 80 ft by 80 ft, so that the airscrew experiments may be carried on independently of the atmospheric conditions. The over all diameter of the whirling table is 60 ft., the dynamometer being carried at the end of an arm of length 30 ft, which is built up of light steel tubes tapering from 1½ in diameter at the axis to 1 in diameter at the extremity. These tubes are spaced 12½ in apart and are connected together by struts The central post of the whirling table is carried up from the floor to the roof, the arm being stiffened by connecting the tubes to a cantilever built up of light angle iron and provided with cross bars and steel wire ties The whirling table is driven by a 14 hp electric motor, through a worm reduction gear of 28 to 1

Fig 1 Whirling Table at the N P L

To avoid straining the central post by the inertia of the arm when the motor is stopped, the post is cut immediately above the worm wheel and the upper and lower parts connected by a ratchet gear which allows the free rotation of the arm

The speed of rotation of the whirling table, which is regulated by an adjustable resistance in the armature circuit of the motor, can be varied from 3 to 17 r.p.m., corresponding with translational speeds at the end of the arm of 6 to 35 m.p.h

For the purpose of transmitting current to the motor driving the airscrew, and also to the measuring apparatus, during the rotation of the whirling table a set of eight slip rings are fixed to the post.

The airscrew shaft is driven by an endless rubber belt by a 2 hp motor carried on the arm, the speed of the motor being regulated from an observation table in the corner of the whirling shed

A small revolution counter driven by the airscrew shaft is connected electrically so as to ring a bell every hundred revo-

* See the later reports of the Advisory Committee for Aeronautics

lations, the airscrew speed being timed with a stop-watch for a period of about two minutes. A second bell rings at each revolution of the whirling table, so that by timing the rings against a stop watch the speed of rotation of the whirling

reduction of air pressure due to the centrifugal head in the connecting pipe the reading of the manometer is proportional to $V^2 - v^2 - V^2$, that is, $v^2 - 2vV$, from which the velocity of the swirl may be calculated since V is a measured quantity. The

Fig. 2 Propeller Dynamometer—General Arrangement

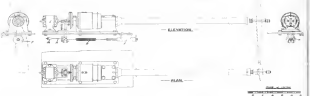

table and hence the speed of translation of the airscrew due to motion of the whirling table may be calculated

As would be expected, the air in the whirling shed is set in motion by the whirling table and also by the backwash of the airscrew, the velocity of translation of the airscrew through the air being obtained from the measurements of both the velocity of translation of the airscrew due to the rotation of the whirling table and the velocity of swirl of the air. The velocity of this air swirl is measured by a Pitot tube mounted at the end of a light arm opposite to that carrying the airscrew, the tube following the airscrew at a distance of about 100 ft so that it is well out of the region of the direct action of the

speed of the air swirl, when the airscrew is not working, is about 8 per cent of the arm speed.

A measurement of the air swirl is made at each determination of the performance of the airscrew since the swirl velocity depends on both the rotation speed of the whirling table and the slip stream at which the airscrew is working. At a low translational speed when the airscrew is giving a big thrust the velocity of the air swirl may be negative

Description of the Airscrew Dynamometer

Two sketches of the airscrew dynamometer, a general arrangement and a sectional drawing, are given in Figs. 2 and 3

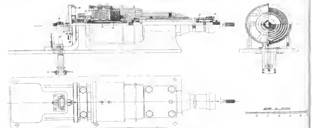

Fig. 3 Propeller Dynamometer—Section

slip stream. The tube is connected through an airtight mercury seal at the top of the central post to one limb of a manometer, the other limb being open to the atmosphere.

If V be the velocity of the end of the whirling arm and v the velocity of the air swirl in the shed, the velocity of the tube relative to the air is $V—v$, so that taking into consideration the

The dynamometer was designed to measure a maximum thrust of 15 lb and a maximum torque of 4 lb./ft., but with model airscrews of ¾ scale measurements greater than 4 lb for the thrust and 1 lb./ft for the torque are rarely made.

The airscrew shaft is driven through flat coiled springs, the extension of the springs, which is proportional to the

torque, being measured by the relative displacement of a pointer over a small drum a, which carries a small slip of paper. The position of the pointer at any time during the experiment is recorded by passing a series of sparks through the paper, so that if the zero position of the pointer is also

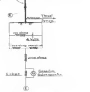

Fig 4 Diagrammatic Sketch of Thrust Balancing Apparatus

recorded on the paper the magnitude of the torque may be directly calculated from the known calibration of the springs.

Alternate torque springs are wound in opposite directions so that tendencies to unwind due to centrifugal force almost counterbalance each other. A small torque correction, the magnitude of which is a function of the rotational speed, is made to each torque measurement

The airscrew shaft is allowed a small axial movement, about 1/200 in., by the use of the ball bearings p, p, p, which have parallel outer races. The end of the airscrew shaft bears

against an oscillating lever d which is pivoted at its center, the lower end of the lever being directly controlled by the thrust spring b, the tension in which is adjusted by the poppet head f, and two adjustable stops c, c', both stops being insulated electrically from the rest of the dynamometer

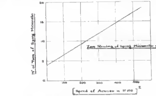

Fig. 5 Reading of Poppet Head Plotted Against Square of Rotational Speed

The method of indicating when the thrust of the airscrew is balanced by the pull of the spring is illustrated by the diagrammatic sketch of Fig 4. From the diagram it is seen that the direction of the current through the galvanometer depends whether the lever is touching stop c or stop c'. When the thrust of the airscrew balances the pull of the thrust spring, and the oscillating lever is floating midway between the two stops, currents of equal magnitude but of opposite direction flow through the galvanometer so that the galvanometer needle is not deflected owing to the inertia of the moving parts of the

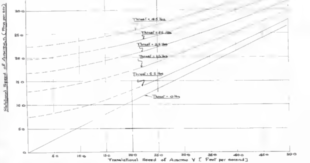

Fig. 6 Relationship Between Translational and Rotational Speeds at a Constant Thrust of an Airscrew

galvanometer and the inductance of the circuit

The sensitivity of this method of balancing is very great, and it will be noted that the accuracy is not affected by any variation of the battery voltage. Moreover, any variation of the contact resistance at either stop is very small compared with the large resistance of the circuit. Each stop has a hardened steel point which makes contact with a small flat hardened steel disc at the bottom of the oscillating lever.

Oscillations in the torque springs due to any small irregularity of the driving torque are damped considerably by the oil dash pot K, in Fig. 3. The dash pot consists of a series of concentric discs, alternate discs being attached to a sleeve carrying the inner ends of the torque springs, and to the drum, to the inside of which are fixed the outer ends of the springs. The vibrations of one end of a torque spring relative to the other are damped out by the viscosity of the oil between the two series of discs.

The plane of the airscrew passes through the axis of rotation of the whirling table, and the centrifugal force due to the weight of the airscrew has no component in the direction of the thrust. The centrifugal force acting on the airscrew shaft has a small component in the direction of the thrust which is automatically corrected for by the centrifugal force of a small mass m acting through a bell crank lever u, Fig. 3.

The Method of Conducting the Airscrew Experiments

It is now proposed to describe the method of conducting an airscrew experiment, the article being illustrated with the data taken from experiments on a model airscrew. The scale of the model airscrew was ¼ full size, the diameter of the full-size airscrew being 9 ft. 2 in.

Firstly, the reading of the poppet head f when there is no tension in the thrust spring is obtained from the static experiments on the airscrew, namely, experiments made with the airscrew rotating at a fixed point. In Fig. 5 the reading of the poppet head has been plotted against the square of the rotational speed, from which it is seen that for all practical purposes the static thrust of an airscrew is proportional to the square of the rotational speed.

The reading of the poppet head, when the airscrew is not rotating and obviously giving no thrust, is 3.9 turns, so that from the calibration of the thrust spring—3 turns represent 1 lb.—the thrust of the airscrew at any reading of the poppet head is known.

The testing of an airscrew under working conditions similar to those of practice is now commenced. The thrust spring is given a tension of known magnitude and the whirling table a steady speed of rotation, and then the speed of rotation of the airscrew is adjusted until the thrust of the airscrew balances the tension in the thrust spring, the balance being maintained for a period of about two minutes, during which time the translational speed of the end of the whirling arm, the rotational speed of the airscrew and the velocity of swirl of the air are all measured. At the moments of exact balance of the airscrew thrust, and whilst the measurements of the rotational and translational speeds of the airscrew are being made, the torque is electrically recorded.

The experiments are conducted by two observers, one observing the galvanometer of the thrust balancing apparatus, recording the torque, and measuring the rotational speed of the airscrew, the other taking the measurements of the rotational speed of the arm and the swirl velocity of the air. Usually twenty sets of observations are needed to completely define the performance of the airscrew, each set taking about 4 min.

The data of the experiments made with the model airscrew tested in this instance are given in Figs. 6 and 7. The curves of Fig. 6 show the relationship between the translational and rotational speeds of the airscrew at constant values of the thrust, from which it will be noted that the experimental mean pitch—that is, the distance moved forward into the air during one revolution, when the thrust of the airscrew is zero, is 1.88 ft.

The curves of Fig. 7 give the relationship between the torque and the translational speed at constant values of the thrust. The values of the thrust and torque of Figs. 6 and 7 are to be used for the standard atmosphere of temperature 15.6 deg. C. and pressure 760 mm., the correction factors being calculated from the observations of temperature and pressure taken during the experiments.

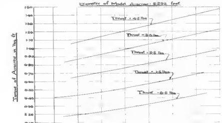

Fig. 7. Relationship Between Translational Speed and Torque at Constant Thrust of Airscrew

The curves of Figs. 6 and 7, which are plotted directly from experimental observations, are not in a convenient form for a ready calculation of the performance of the airscrew under working conditions. A more convenient and compact form of presenting the airscrew data is in terms of absolute coefficients. An absolute coefficient has the great advantage that its value is independent of the system of units employed so long as the units themselves are dynamically consistent, or, expressed simply, an absolute coefficient has no dimension.

Absolute coefficients are thus especially favorable for international comparison of experimental data. The results of experiments as calculated from such absolute coefficients may be directly expressed in practical units on either the English or the metric system.

If V = translational speed of the airscrew
n = rotational speed of the airscrew
T = thrust of the airscrew
Q = torque of the airscrew
D = diameter of the airscrew
and ρ = density of the air,

we may write $T = T_v \rho V^2 D^2$ or $T = T_n \rho n^2 D^4$ so if T, ρ, V, n, and D are expressed in any system of consistent units T_v and T_n will have no dimension and so are absolute coefficients.

In the British text books on dynamics the units of force, mass, length and time are the poundal, pound, foot and second, but the lb.-slug-foot-second system of consistent units is usually employed by the engineer. Accordingly, expressing the density of the air in slugs per cu. ft.—ρ = 0.0762 lb. per cu. ft. $= \frac{0.0762}{32.2}$, that is, 0.00237 slugs per cu. ft. at a temperature of 15.6 deg. C. and pressure 760 mm.—the value of the thrust in lb. may be calculated from the value of T_v or T_n if V be expressed in ft. per sec., n in revolutions per sec., and

D in ft. In a similar manner we may write either $Q = Q_v \rho V^2 D^3$ or $Q = Q_n \rho n^2 D^5$.

In Fig. 8 the performance of the airscrew has been expressed in two ways, first, by plotting T_v and Q_v against $\left(\frac{V}{nD}\right)$, and second, by plotting T_n and Q_n against $\left(\frac{V}{nD}\right)$, $\left(\frac{V}{nD}\right)$ being also an absolute coefficient. Since $T_n = T_v \left(\frac{V}{nD}\right)^2$ and $Q_n = Q_v \left(\frac{V}{nD}\right)^2$, the airscrew performance may be

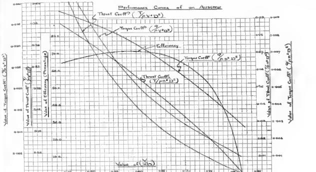

Fig. 8. Performance Curves of an Airscrew

expressed completely by plotting either T_v and Q_v against $\left(\frac{V}{nD}\right)$ or T_n and Q_n against $\left(\frac{V}{nD}\right)$.

The efficiency is the ratio of the useful work done by the airscrew to the total work put into the airscrew so that efficiency,

$$\eta = \frac{\text{Thrust} \times \text{Translational speed}}{2\pi \times \text{Torque} \times \text{Rotational speed}} = \frac{T_v}{2\pi Q_v}\left(\frac{V}{nD}\right) \text{ or } \frac{T_n}{2\pi Q_n}\left(\frac{V}{nD}\right).$$

Efficiency being the ratio of two like quantities is, of course, an absolute coefficient. We see, then, that the performance of an airscrew may be expressed completely in two systems of absolute coefficients—either

$$\left(T_v, Q_v, \frac{V}{nD}, \eta\right) \text{ or } \left(T_n, Q_n, \frac{V}{nD}, \eta\right)$$

and the usefulness of such a system will be apparent from a calculation such as in the following paragraph.

To calculate the values of the thrust and torque of the airscrew at ground level, when it is moving through the air with a translational speed of 75 m.p.h. and a rotational speed of 1200 r.p.m., we express the known data in consistent units, so that

V = 110 ft. per sec.
n = 20 revs. per sec.
D = 9.167 ft.
ρ = 0.00237 slugs per cu. ft. (assuming the temperature of the air to be 15.6 deg. Cent. and the pressure 760 mm.)

The value of $\left(\frac{V}{nD}\right)$ at which the airscrew is working is $\left(\frac{110}{20 \times 9.167}\right)$ that is 0.60, the corresponding values of $\left(\frac{T}{\rho V^2 D^2}\right)$ and $\left(\frac{Q}{\rho V^2 D^3}\right)$ as measured from the curves being 0.157 and 0.0209 respectively. Hence,

$T = 0.00237 \times (9.167)^2 \times (110)^2 \times 0.157 = 378$ lb.
$Q = 0.00237 \times (9.167)^3 \times (110)^2 \times 0.0209 = 460$ lb.-ft.

$$\text{The efficiency} = \frac{VT}{2\pi Q n} = \left(\frac{110 \times 378 \times 100}{2\pi \times 460 \times 20}\right)\% = 72$$

The thrust and torque could, of course, be calculated from the values of

$$\left(\frac{T}{\rho n^2 D^4}\right) \text{ and } \left(\frac{Q}{\rho n^2 D^5}\right).$$

Aeronautical Patents

ISSUED SEPTEMBER 18, 1917

1,240,171—To William C. Robinson Grinnell, Iowa. Landing-Chassis for Airplanes.
1,240,400—To Fabian Zemsitzel, Philadelphia, Pa., assignor of one-third to Joseph Sobelowski Philadelphia, Pa. Launching Device for Airplanes.
1,240,993—To Ellis Capps Forest City, Ark. Flying Apparatus.

SEPTEMBER 25, 1917

1,240,512—To Joseph A. Blondin Los Angeles, Cal. Airplane Construction.
1,241,073—To Stanislaw Paul Zywno Middleton, Conn. Flying Machine.
1,241,082—To Louis Coatalen, Wolverhampton, England, assignor of one-half to Sunbeam Motor Car Co., Ltd., Wolverhampton, England. Internal-Combustion Engine for Airplanes.
1,241,210—To Martin Jelalian Cranston, R. I. Dirigible Airship for Military Purposes.

OCTOBER 2, 1917

1,241,629—To Arthur L. Geary, Walla Walla, Wash. Aerial Vessel.
1,241,868—To James S. Long, Boston, Mass. Plane for Flying Machines.

Description of the Austrian Albatros Biplane

Hansa-Brandenburg Type, 200 HP. Warchalowski Engine

In the Oct 15 issue of AVIATION AND AERONAUTICAL ENGINEERING there were published detailed drawings of the Austrian Albatros biplane, Hansa Brandenburg type, equipped with a 200 hp. Warchalowski engine. The following official detailed description of this airplane is now made public.

The enemy airplane described, which was captured almost intact in 1916, does not differ sensibly from those of the same type in use since the beginning of the war. It shows no substantial improvements, except slight changes with regard to the position of the radiator, the housing of the engine, the tail planes, etc. The general outline of the aircraft as regards the body, the landing gear and the main body have undergone practically no changes from the beginning of the war to this day.

To cope with the latest means of defense on land as well as in the air, the first requirement of an airplane, even if for reconnaissance work, is its high speed, whereas the Hansa-Brandenburg, judging from the pitch of the propeller, cannot exceed 155 km. That part of the angle of vision which is so highly prized by most pilots is obstructed here by the engine, which stands high for the sake of stability, and by the radiator.

Nor does the radius of action prove to be high. Judging from the speed and from the gasoline supply the machine cannot make, under the most favorable circumstances, a trip of over 550 km, which is very limited for a reconnoitering plane.

Pilot and gunner are completely exposed to the fire from enemy machine guns. Only from below are they slightly protected by a thin armor on their seats. The center of gravity of the plane, by actual calculations, has been found with full load to be 10 cm. above the axis of thrust whereas at the end of the trip, when the fuel supply is almost exhausted, it goes as high as 20 cm. above the said axis.

The center of gravity moves about considerably longitudinally, owing to the fact that the gas tank, which serves also as seat for the pilot, is located far behind the center of gravity of the machine.

Moreover, the center of resistance is high with respect to the axis of thrust, due to radiator wind shields, machine guns, the large fixed tail plane, etc. In view of the poor location of the centers indicated, and the poor means of control, due to deficient active surfaces or to their limited action, the machine neither can be easy to handle nor show a high degree of stability.

Because of the wing section used, the position of the spars, which are very close to the leading edge, and also because of the big gap between the upper wing and the lower one, the rear upper spar receives the greatest stress, though it is about the same as that of the front spar. If the machine is pulled sharply out of a steep dive, which has raised its speed far above normal, the angle of attack being always rather high, the point at which the lift is applied will have moved towards the middle of the wing, assuming that that point will be located at least 0.4 of the chord from the front edge. According to common mathematical data used to calculate the resistance of our machines, the coefficient is less than 5.

Neither can the static factor of safety of the body be very high, since the four longerons, which make up its frame, are much smaller than those commonly used in similar bodies of our airplanes. Therefore, the machine must be handled with care, owing to its insufficient strength.

Brief Description of the Machine

The Body.—The body is of good stream line form. The sides consist of vertical members connecting the longerons.

The framework consists of four fir longerons, properly strengthened by cross-frames and the whole rendered solid by a good triple-laminated sheathing. The smallest cross-section of the longerons at the tail end, between diaphragms is 2 sq. cm. This cross-section gradually increases until in the front part of the machine its maximum is 12 sq. cm.

Two kinds of transverse frames, varying in strength, are used. The stronger frames, which are rigid diaphragms consist of a 15-mm fir center, covered with two layers of 3 mm laminated wood to increase the strength, and are placed where the body is subject to high stress. The other frames, which consist of simple non-rigid squares of fir lath, trapezoidal in shape, are used mainly to back up the laminated wood sheathing.

At the junction of the wing spars with the body, the structure is strengthened crosswise by steel tubes, 30 mm in diameter, which make a solid piece of the whole structure. In the front part of the body the cross-framing consists of the brackets which support the engine bearers. These are made of tri-laminated wood ranging in progressive thickness from the smallest of 20 mm to the largest of 35 mm. The engine bearers project beyond the front diaphragm of the body about 15 mm.

The Tail Skid.—The detail of this part of the machine is very interesting, and is evidently the result of much study especially because of the way in which the cardan or swivel has been worked out.

The Tail Planes.—One of the characteristics of these machines is the enormous fixed tail plane, 3.84 sq. m. The elevator, which is 1.65 sq. m, is attached to the fixed plane and has exactly the same shape as the latter.

The vertical fin is rather small. It has a surface of 1 sq. m and balances by about 1 to 5. The ribs of these planes consist of steel tubes varying in diameter from 12 to 20 mm. Only the two pairs of fixed and movable tubes, which are used respectively to support the fixed planes and the rudder, are 25 mm in diameter. Of these two fixed tubes, both the horizontal (elevator pivot) and the vertical (rudder pivot) are braced with steel wires, in some machines the lower wires leading to the horizontal fixed tube are replaced with a tube which takes both tension and compression.

Of great interest are the details of the tubes connecting the tail planes with the end of the body and the hinges attaching the rudders to the fixed plane.

The Landing Gear.—This is of the usual wheel type with elastic springs. The chassis struts are 35 x 70 mm tubes, filled with wood, arranged V and joined at their apex by a horizontal tube 32 mm in diameter. The two front struts, the horizontal tube referred to above and the bottom of the body are made (perfectly rigid) by crossed steel cables 6 mm in diameter. The front diagonals are fastened to the sockets, which connect the front struts of the landing gear with the longerons of the body.

Especially worthy of note is the fact that in some machines of this type the elastic support of the axle as well as that of the tail skid is replaced by a metal spiral spring.

The cloth-covered wheels, 770 mm in diameter and 100 mm wide, offer nothing of interest. In the center of the axle is mounted a spring which is operated by the pilot to lessen the run on the ground on landing. The application of such resistance on the axle may, if not used with care, cause the machine to turn over on landing.

Gasoline Tanks.—Owing to lack of space at the center of pressure, the tanks have been placed about 400 mm to the rear thereof and are used as a seat for the pilot.

Wing Assembly.—This differs from our biplanes in two main points, namely, the excessive stagger of the wings (the upper wing projects forward 480 mm beyond the lower) and the inclined interplane struts with respect to the plane of longitudinal symmetry of the machine. The excessive stagger as has been said, suggested perhaps by the necessity of increasing the range of vision of the pilot, reduces the strength of the body and probably reduces in this case the efficiency of the wings, whereas the inclined interplane struts, whose object is to equalize the unsupported lengths of the upper and lower spars, unnecessarily complicate the whole connective system. We say unnecessarily because by placing the uprights vertically and by leaving unchanged the distribution of the trusses of the upper spar, the lower spar would most assuredly have obtained greater strength. The struts are made of tubes 32 mm in diameter, which are faired by a small wooden frame covered with cloth.

The strut fittings on the spars are constructed in a very rough way, all weldings being autogenous, they are very heavy and offer great head resistance.

The panel bracing consists of simple steel cable of six

strands, all panels use the same size of cable. The lift cables run from 7 mm. in diameter for those close to the body to 5 mm for the outer cables, whereas the landing cables are 5 mm near the body and 3 mm for those of the end trusses.

The wings are perfectly symmetrical with respect to the axis of the machine, the couple of the engine being corrected by a diversity of incidence, but this gives rise to inconvenience when changing the rate of speed.

The wing section used does not turn upward, and this tends to move the center of pressure somewhat to the rear and to increase the stress on the rear spar, which is only 0.53 of the chord from the leading edge. The wing section is not very slender, because the front spar is placed too far ahead.

To prevent great horizontal strains on the wings due to head resistance, and especially due to the stagger between the wings, drift cables are used from the upper ends of the two front struts nearest to the body, which are secured to the two front ends of the longerons. Also the two forward lift wires next to the body, for the same purpose, are secured to the end of the upper forward struts of the chassis.

The wings are fastened to the body with a cabane of metal tubes, 30 mm x 45 mm., strongly fastened to each other and forming one frame. Provision is made so that the upper wing may move slightly longitudinally so as to secure a good balance for the machine.

The lower wing almost touches the body; the attachment of the front spar is secured by means of a metal projection of suitable thickness engaging a jaw formed on a tube, which extends across the body until it reaches the other spar. The rear spar connects directly to the diaphragm, to which is also fastened the rear strut of the chassis.

The upper wings as well as the lower ones are internally braced by compression members of 25 mm. steel tube and cable 4 or 3 mm in diameter for the bays near the body, and 3 mm steel wire for the ends.

The diagonal in the transverse planes between the front and the rear struts are very strong, consisting of cable 4.5 mm in diameter close to the fuse and 3.5 mm in diameter at the ends of the wing.

RESPECTIVE WEIGHTS OF PARTS

Machine with wings, tail fins, radiator, radio outfit, gasoline, oil, machine guns, tools, etc.		614 kg
Weight of radiator without water	2[illegible] kg	
Weight of water	18 kg	
		43 kg
Tail Fins—Vertical rudder and fixed empennage including controls	[illegible] kg	
Elevator (as above)	[illegible] kg	
Fixed horizontal plane	[illegible] kg	
		1[illegible] kg
Wings—Lower left included only diagonals (excluding struts)	20 kg	
Upper diagonals	7 kg	
Lower right	[illegible] kg	
Upper right	[illegible] kg	
Struts	1[illegible] kg	
Armament—Machine gun mounted on the wing	10 kg	
		172 kg
Accessories	1[illegible] kg	
Mobile gun and a magazine	1[illegible] kg	
		30 kg
Instruments on board	[illegible] kg	
Radio	1[illegible] kg	
Two pilots	1[illegible] kg	
Gasoline	100 kg	
Oil	17 kg	
Feed supply behind the fixed machine gun	70 kg	
		[illegible] kg
Whole weight of the machine		1 211 kg

LOCATION OF CENTER OF GRAVITY LONGITUDINALLY

Items	Weights	Arms	Moments
Radio outfit	1[illegible]	10	[illegible]80
Radiator	4[illegible]	[illegible]	2 [illegible]
Body, etc.	614	75	46 000
Gun on wings	122	98	12 000
Struts	19	105	2 000
Fins	80	116	9 280
Lower wing	58	122	7 100
Machine gun	75	166	12 450
Mobile gun and magazines	22.5	187	4 170
Tail fins	111	300	[illegible]
	1 8	391	1128
	1 0[illegible]		102 994

HEIGHT OF THE CENTER OF GRAVITY

Items	Weights	Arms	Moments
Machine gun on wing	17.5	[illegible]	3 200
Gunner	75	77	4 120
Radiator	43	50	2 150
Rudder	8	[illegible]	264
Machine gun	22.5	21	585
Body and accessories	614	11.5	928
Fixed fin and elevator	11	110	151
Struts	19	12	228
Pilot	80	8.[illegible]	680
Gunner	75	2.5	187
Radio outfit	15	10	150
Lower wing	58	32	1 830
	P 1 028		N 14 488

Kiln-Dried Airplane Woods

The Forest Service, Department of Agriculture, authorizes the following:

When the United States entered the war the need for wood to build airplanes quickly created a difficult problem. Most of the air-seasoned wood available had been bought for airplanes for the allied nations abroad. Through air-seasoning of such stock requires from one to three years, according to the size and kind of wood. Kiln-dried stock under the methods ordinarily used has frequently proved unsatisfactory, and for that reason airplane manufacturers have been reluctant to use it. If the needs of the fighting forces were to be met adequately and without prolonged delay, it was essential that methods of conditioning should be available in which full confidence could be placed.

Long before this situation developed the forest products laboratory of the Forest Service, at Madison, Wis., had been making a scientific study of the drying of wood, and had developed a method of drying which has been very successful with all the woods tried. Several kilns have been built at the laboratory for experimental purposes and a number of demonstrations made in commercial kilns. Ash and spruce are the woods most in demand for airplane construction, and anticipating the present situation, the Forest Service secured a shipment of partially air-seasoned ash and spruce plank for preliminary tests.

This material was kiln-dried without injury. Later thoroughly green Sitka spruce, white ash (northern and southern), white oak, Douglas fir, western white pine, and mahogany were secured in the log for testing. The spruce and ash logs were cut up and the green material from each species divided into three matched groups. One group of each species was tested green, another has been set aside to be tested when it has air dried, and the third group was kiln dried, trying several methods, and then tested.

Only the results of tests on the spruce have so far been analyzed. Comparison with standard tests which had already been made shows that Sitka spruce can be kiln dried from the green condition with no more, perhaps less, injury to its mechanical properties than by air-seasoning. Definite specifications have been prepared for kiln-drying spruce green from the saw for airplane construction, and, if rigidly enforced, they will insure kiln-dried stock of this species equal to air dried stock.

A preliminary study of propeller construction has shown the need of such information on propeller woods. The testing of the ash and other species now on hand, which include several propeller woods, is being pushed as rapidly as possible, and there seems reason to expect as favorable results as for the spruce.

Book Reviews

ACQUIRING WINGS. By William B. Stout. Moffat, Yard & Co., New York (57 pp., 75 cents).

This book gives the basic principles of aviation in simple and concise language. The fundamentals of airplane design and construction, which the ground student should know preliminary to his actual training in the air, are here dealt with more exhaustively than is often found in much more ambitious volumes. Some excellent illustrations accompany the text.

The author is a recognized expert on aeronautics and is now in Government service. Altogether this little volume should prove a valuable introductory guide to all those who are taking up the study of aviation.

LEARNING TO FLY IN THE U. S. ARMY. By E. N. Fales. McGraw Hill Book Company, Inc., New York (177 pp.).

The contents of this book run parallel to the instruction given under the author's direction in the U. S. School of Military Aeronautics at the University of Illinois. Its contents cover, therefore, all of the theoretical part of aviation which aviator cadets are expected to have gathered during their stay in a ground school.

Comprehensive chapters are devoted to the types of military airplanes and uses, the principles of flight, the mechanics, the rigging, and erecting of airplanes, materials of construction, cross country flying, etc., etc.

This handy book, which is of pocket size, should be of the greatest help to the aviator cadet for constant reference in the preliminary stages of his training.

Finishing Up and Balancing Airplane Propellers*

By Frank W. Caldwell

After the propeller has been roughed out it is desirable to let the wood season for a while before finishing. The present American practice is to allow only a few days for this seasoning. It is the opinion of the writer, however, that longer seasoning is desirable. For proper seasoning a period of one month at a temperature of about 80 deg. Fahr. and a relative humidity of from 45 to 55 deg. is recommended.

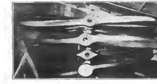

FIG. 1. RACK STAND FOR SEASONING PROPELLERS

For this seasoning the propellers should be hung up on racks similar to the one shown in Fig. 1. This rack consists of an upright wooden post 4 in. square with pieces of 1 and 1¼ in. iron pipe stuck through it.

The photograph was taken in a storeroom on the Mexican border. In this case it was found necessary to keep the floor wet down and a number of buckets of water standing in the room to maintain the humidity necessary to preserve the life of the wood.

By hanging the blades in a horizontal position a uniform circulation of air is maintained and the drying is done uni-

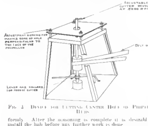

FIG. 2. DEVICE FOR CUTTING CENTER HOLE IN PROPELLER HUBS

formly. After the seasoning is complete it is desirable to install the hub before any further work is done.

The hubbing practice is at present very unsettled. The European practice is to allow one sixty-fourth of an inch oversize holes for the large center hole and for the bolt holes. In this case the whole drive must depend on the friction of the flanges.

In American practice it has been considered desirable to make the hub flanges as small as possible in order to save weight. In some cases the flanges have been made so small that the friction alone was not great enough to drive. Then it was necessary to have a neat press fit of the hub in the large center hole and a driving fit of the bolts in the bolt holes, in order to make the bolts do part of the driving.

A simple calculation will show what would happen in case the friction of the hub flanges were not great enough to drive the propeller and the bolts were fitted one sixty-fourth inch loose in the holes.

Take the case of a direct drive eight-cylinder engine turning at 1400 r.p.m. There will be $4 \times 1400 = 5600$ pulsations per

FIG. 3. "TRACKING" THE BLADES

The surface gage is set at the height of the point a and the propeller is swung round through 180°. The point b equidistant from the axis is then trimmed down by the gage to the same height as a

minute. Since the propeller is a flywheel it must absorb these pulsations. If the friction of the hub flanges is not great enough to drive, the flanges will slip at each pulsation until they come in contact with one side of the bolts and then slip back until they come in contact with the other side.

The distance traveled by the flange will be $2 \times 1/64$ in. or $1/32$ in. The distance traveled per minute is $5600 \times 1/32$ in. or 175 in. per minute. It is hardly necessary to state that the wood is soon burnished in a case like this. As a matter of fact the writer has seen propellers charred and completely burned out of shape at the hub after ten or fifteen minutes in a case of this kind.

The advantage of the European practice is that the small

FIG. 4. ALIGNMENT OF THE BLADES

A line joining any two points a and b must pass through the axis of the propeller. This may be tested with a straight edge or with fine wire. a and b are two points on the trailing edge equidistant from the axis.

hubs are easily installed and changed in the propellers. Also there is no chance of splitting the wood by a bolt that is too tight.

The advantage of the American method lies in the saving of weight which, of course, is of foremost importance.

In order to get a clean-cut center hole for the hub the use of a device similar to that shown in Fig. 2 is recommended.

The bolt holes should be drilled by means of a jig drilling half-way through from each face.

Before installing the hub, four or five coats of linseed oil should be applied to the inside of the hub hole and bolt holes. The whole surface covered by the hub should then be coated with shellac.

The hub bolts should be pulled up as tight as the threads will permit. Of course, it is necessary to alternate from one side to the other in tightening the bolts to avoid drawing the flanges out of line.

The propeller with the hub installed is now fastened in place on a lay-out plate. The trailing edge of one blade is now accurately cut down to correspond with the propeller

* The present article is the third and last of a series dealing with the construction of airplane propellers which has been contributed by the author to AVIATION AND AERONAUTICAL ENGINEERING, the first article having appeared in the issue of May 1, 1917, and the second in the issue of Oct. 1, 1917.

shown on the drawing of Fig. 3. This work is done with a spoke shave.

Each point on the trailing edge of the other blade is now made to "track" with the corresponding point on the first blade. Failure to track throws the propeller out of balance dynamically, but is only shown up statically by measurement. Fig. 3 shows the method of "tracking" the blades of the propeller.

After the blades are tracked it is necessary to align them so that a line passing through two corresponding points on the trailing edges will pass through the axis of revolution. Failure to align the blades will throw them out of balance statically as well as dynamically. The method of aligning is shown in Fig. 4.

The trailing edges are now used as reference lines, and the blade angles are worked down from these lines by means of a protractor or a pitch card. Care must be taken to see that the lamination lines form a fair curve between stations.

After the face has been formed the back shape is obtained by working to templates. The work is finished down to within about one-sixteenth of an inch with a spoke shave and is then finished with a patent scraper.

That portion of the blade between the hub and the first station is usually formed by the eye, the lamination lines being cut down to a fair curve.

The next operation is that of balancing. Fig. 5 shows a good form of balancing stand. The propeller is balanced in two positions, as shown in Fig. 6 and Fig. 7. It is considered desirable to remove stock for balancing from the face of the

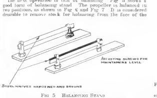

FIG. 5. BALANCING STAND

blade rather than from the back, since variations of camber of the under side of a wing have less effect on its aerodynamic properties than variations in the shape of the upper side. It is obvious that changes in the lift coefficient of a section on one blade only will throw the propeller out of balance aerodynamically.

After balancing, the propeller must be sanded to a nice surface. Three grades of sandpaper recommended are No. 2½, No. 1½ and No. ½. Care must be taken to rub along the grain and never to let the paper rub across it. A single stroke across the grain will spoil the finish unless the marks are carefully rubbed out.

The propeller should now be given about four coats of linseed oil, balancing carefully after each coat. A nice finish may be obtained by rubbing with a mixture of linseed oil and shellac. The shellac is mixed very thin with alcohol and a piece of cotton is soaked in it. A piece of cheesecloth is wrapped around the cotton to form a pad. Linseed oil is applied to the propeller in small drops and the shellac is rubbed in vigorously with the pad. Patience and a little care will enable one to get a fine polish. It requires about three hours' rubbing to properly polish a propeller.

The use of a paste filler and varnish is not recommended, as the filler does not penetrate and a small scratch will expose the wood to the weather.

Sheathing with Copper or Monel Metal

To protect the tips of the blades from the abrasive action of sand and small stones and from spray in the case of a seaplane propeller some form of sheathing is usually applied.

The question of the usefulness of sheathing does not pertain to the subject of this article. It may be stated briefly, however, that the present tendency is to use sheathing only on seaplanes.

In case copper is used for sheathing, the sheets should be carefully annealed before they are used. The sheets for the face and back side should be cut to shape and formed to the blade shape. The tips are now clamped in place and their outline is marked on the blade. A recess is cut along this outline so that the copper will come flush with the wood when the tip is applied. The copper sheets are again clamped in place and holes are bored for the rivets. A good size of rivet is about .085 in. and the holes are bored to give a driving fit in the wood.

After all the holes are bored the tips should be removed and all the holes should be filled with linseed oil. This precaution may seem superfluous to the shop man, but the rivet holes are a frequent source of season checks in the field.

The tips may now be applied permanently and the rivets driven through and beaded over. Each rivet is soldered to the copper plate and the seam where the two plates overlap is

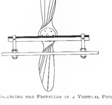

FIG. 6. BALANCING THE PROPELLER IN A VERTICAL POSITION

carefully soldered. The surface is filed smooth and the propeller is again balanced by the application of small amounts of solder to the light blade.

Sheathing with Monel metal is carried out in the same way except that the metal is much more difficult to work and requires more skill in applying.

Sheathing with Linen

In case the blades are to be sheathed with linen they must be absolutely clean and no oil or other coating must be applied.

The cloth must be carefully scrubbed with washing soda and rinsed in hot water until all the sizing is removed.

The back side of the blade is coated with Scotch glue and the cloth is applied and rubbed down smooth. It is then ironed with an electric iron to improve the adhesion. The work must be done in a room at a temperature of about 100 deg.

The cloth is trimmed even along the edges. The cloth on the face side is applied in the same way except that it is allowed to lap about three-quarters of an inch over the back.

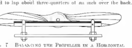

FIG. 7. BALANCING THE PROPELLER IN A HORIZONTAL POSITION

After the glue has set for about twenty-four hours, four coats of airplane dope may be applied, followed by two coats of battleship gray enamel.

To give a good appearance the surface should be rubbed to a French polish with oil and shellac.

The Future of Commercial Aeronautics*

By Lieut.-Col. Merlyn O'Gorman, C.B.

Commercial aeronautics is clearly one of the subjects requiring foresight, technical, political and financial. Broadly, the objective is simple, in detail it is very complex. This at once suggests analysis as a help toward foresight. Commercial aeronautics can be divided into three parts

(a) The home or internal aspect

(b) The foreign or international aspect

(c) The Imperial and Colonial aspect

The internal British question can be resolved into five separate subject matters for study, and as each of these has subheads, I tabulate as follows, drawing attention to the two main heads—(1) the production, and (2) the utilization (or "aerial transit") problems, corresponding roughly to supply and demand.

It will be found that the profitable use of aircraft is based on speed, and that as speed of transit includes door-to-door movements, if there are, as we see at present, considerable terminal time losses, the longer the distance over which aerial work is conducted the less significant are the "terminal charges" upon our time of transit. This merit introduces for a small country, the advisability of studying flight beyond its borders, and for an island the consideration that shipping is slow compared to the railroad or automobile. Therefore international flying will come up early in our development of aerial transit, and may be expected to concern movements over the sea, not necessarily in seaplanes.

But we cannot go abroad without our tickets, our circular notes and passport, so that we cannot fly over another country without making arrangements. These arrangements will be easily made if there is a body of opinion abroad which is favorable, which recognizes that it will not get landing rights in British possessions unless British aircraft have landing rights on foreign soil. One of many ways of securing such a body of opinion favorable to aerial transportation in the prize lands themselves is to institute industrial links between our own constructors and foreign constructors, whether as "succursales" or joint firms, or shareholders, or agents. I therefore put these first and tabulate five subheads.

If we develop our aircraft making and using property we shall be the first to wish that other countries may be equipped with "aerial ways" (lines of landing grounds), aerodromes at big centers of industry, finance or pleasure. Moreover we want to find elsewhere not only the maps, but also most of the safety provisions desirable at home. All these things will be fostered by the energies of societies like the Aeronautical Society and the Society of British Aircraft Constructors which we should like to find abroad and enter into relations with. At present they are not nearly as active abroad as at home. They might be fostered not only officially, but rather through the intermediary of our industrially linked firms, whether for construction or transit.

One of the important matters for consideration is the avoidance of cutthroat competition at a time when it is always difficult to insure a remunerative investment with any certainty. This involves the inter-State provision of what may be termed limited monopoly for certain services at least, until the businesses are well launched and till statistics exist in which in surplus operations can be satisfactorily placed. Firms can be trusted to make their own value felt by the Post Office and by passengers whom they desire to attract, but they are defenceless against one another if as soon as one energetic individual has initiated an enterprise the value of his strenuous work is to be poached upon by irresponsible persons (who may, it is true, ruin themselves undeplored), but who may drag into a like ruin those whose industry and courage founded the whole scheme. The Government should step in here in the interest of maintaining what it must maintain, a large, successful and enterprising industry.

It may here be worth while to say why the country must do this. It is a matter of certainty. The air fleet differs materially from the sea fleet in being more rapidly expendable. No one would dream of rebuilding the British fleet six or eight times per year of war. Yet the air fleet requires at least this. Thus the airplane occupies an exciting position halfway between a battleship and a cartridge. To decide on having an air fleet for war is synonymous with having an aircraft industry in peace competent to produce some eight air fleets per annum when called upon.

TABLE A. ANALYSIS OF SUBJECTS ENTERING INTO INTERNAL BRITISH AERONAUTICS

The Uses of Aircraft	The Safety Provision	Formation of Personnel	Production of Aircraft	General Question
(a) Transit of goods. (b) Transit of letters. (c) Transit of persons. (d) Labor of transit service. (e) Finance of trans-aerial companies. (f) Government subsidization of aerial transport. (g) Private sporting and domestic use. (h) Scientific use surveys etc.	(a) Aerial routes lines of landing grounds maps. (b) Night flying lighting. (c) Aerology meteorology. (d) Wireless communication of distress orders signals of directions. (e) Labor of ground upkeep etc. (f) Subvention of safety precautions and grounds. (g) Accidents investigation. (h) Keeping of records. (i) Insurance of—(1) pilots (2) passengers (3) craft.	(a) Designers, engineers. (b) Flyers, navigators. (c) Military call on flyers. (d) Polytechnic and correspondence schools for labor. (e) Subvention of education. (f) Initiation of design research. (g) Inventions. (h) Consular trade information etc.	(a) Best employment of existing factory organization. (b) Finance and subsidies to makers. (c) Military and naval requirements. (d) Publicity and tentative orders. (e) Utilization of surplus of military and naval war orders. (f) Supply of aircraft to foreign governments and dominions.	(a) Male and female labor including military wounded pensioned etc.

Commercial and Postal Uses of Aircraft

As we have recently had a suggestive paper on airplane transport, giving rough costs on a certain route, I will not dwell on it save to recall the existence of the airship and to touch on one matter which I raised in the discussion and to which Lord Cowdray also addressed some remarks. I allude to the danger of the hiatus which might occur between the war demand and the peace demand. There appears here all the value that attaches to promptness in giving, and all the difficulties that attach to the exercise of foresight.

In another sphere we know, that to secure the return of soldiers to the land, a parliamentary commission has already recommended that immediately on the declaration of peace 20,000 cottages shall be built at or near the land they are to till, thus utilizing the building skill now in the ranks and starting the homes for our men on the land. So far as the housing of workpeople near centers of aircraft production is concerned, this may be said to have been largely provided during the war. What has not been foreseen even on paper with a like definiteness is the absorbing of our aircraft output and the incidentals thereto. The financing and laying out of the specific postal routes, the location of the mechanics, repair men and liners at the ports of departure and arrival, the housing of aerodrome officials, groundmen, accountancy clerks, the automobile service from town to aerodrome, the purchase of land and the establishment of title, the preparation of lists of aviators who may desire to find occupation at once instead of losing their skill by many months' inactivity, the preparation of such drawings as may quickly allow of adapting war aircraft designs to their new uses, and the designing of such new weight carriers as may be more suitable to transport work, some or all of these things are needed if the industrial organization of the factories is not to crumble during a long hiatus. Six months of idleness will disrupt any factory organization and will lead to the paying off of workpeople and their consequent suffering and discontent. This six months of idleness must not occur.

It must be admitted frankly that the preparation of such schemes is not only laborious, but dishearteningly dependent

* Excerpt from the Fifth Wilbur Wright Memorial Lecture delivered before the Aeronautical Society of Great Britain

on circumstances beyond the control of the organizer. Still, just as in peace time we work out complete plans for war condition which might arise, so in war time we do paper work for peace conditions, even if some of that paper work is wasted.

We have had one skeleton scheme to awaken the imagination, but we must have many to save the situation. We are confronted with the position that the mere housing of one month's output of the aircraft builders together with the returned war stocks, as soon as the rapid wastage ceases, is a matter of intense difficulty. Thus we are led to formulate the desire that sales of military aircraft to foreign countries, colonies, private users, exploitation companies at home and abroad shall be as prompt as they can possibly be made by every exercise of forethought, subject only to the retention of such devices and machines as are reserved by the military authorities for special reasons.

The policing of the air, though eventually a means of using a number of armed aircraft without appreciable alteration, can only at first consume aircraft on a small scale, however carefully such a scheme be laid out for expansion when the trade develops. It would be putting the cart before the horse to provide for more police than there are potential malefactors or to provide for enforcing the "rules of the air" on a non existent traffic.

Future Production of Aircraft

The bugbear of any production is the uneven distribution in time of the orders received. The intolerable burden of keeping a staff and a system to give a large rate of output for a short time and at short notice should, if possible, be put an end to by foresight. The Government will necessarily have certain orders of its own to distribute, and if it be found that like the automobile trade the industry is fed up by a season demand, then the Government orders might, if possible be distributed at such dates and in such a way as to even up the load curve.

I do not pretend to detail the good or bad effects of the army, navy, post office and "transaerian" companies and foreign and Colonial Governments all invited tenders on April 2 and placed the whole of their orders on May 1, to the gorging of the lowest tenderers and the ruin of those who made correct estimates, but I do suggest that there existed no organization prior to the war for appreciating the factory point of view in the distribution over a period of time of the business of ordering, and I also suggest that any industry with a first-class chance of a steady turnover has also a first-class chance of supplying an article at once profitably and cheaply—two terms which cannot always be justifiably found in juxtaposition.

The labor question is involved in this same consideration for the same reason. The laborer's desire for his share of wealth is no doubt accompanied by the knowledge that it must be produced to be distributed, but this is overshadowed by the conviction that the firm may fail to get more orders, that a lull may come and that he can extend the period of activity between the lulls and secure jobs for his friends by working dead slow. Abolish the lulls, and the thin excuse for slacking vanishes.

Control of Customs

It seems to me that a trading airplane can cross a frontier unseen either at great height or by using clouds or at night. It can drop packages at spots prearranged with confederates and can, without alighting, either return to its own land or continue upon its through journey and escape being identified by a Customs House officer almost any night of the year.

In Nov., 1913, a few remarks were made on the subject of customs, and it was pointed out that a customs inspection of the contents of aircraft on departure on behalf of the country of call was unthinkable, while inspection on arrival or on dropping goods, involves all countries in having Custom House officials over so large a part of their surface as to suggest that the number of officials would be excessive.

I think it may be decided to be impracticable and conducive to the stifling of aeronautics to make it obligatory on all entering aircraft to concentrate upon some agreed ports of entry. Such a concentration would be highly inconvenient and the delay of alighting would be contrary to the very first desideratum of an air service speed. It will be time enough later to consider the control required over aliens who might enter with diseases subject to quarantine.

Each arrival aerodrome would be liable at times to become a pandemonium of delayed and angry aeronauts. But there are other objections. One would hope to see journeys navigated on a course specially selected to utilize the enormous advantage of favoring winds, and minimize the delay and expense imposed by contrary winds, and therefore such journeys would be planned without the hampering influence of arbitrarily imposed places of call. These plans would seemingly be liable to alteration in the air according to the wind encountered, so as to obtain the best economic results. It will assist in making aeronautics a wealth-producing industry instead of a burden to the State, if it is possible to secure that through journeys be made, when desired, without any compulsory stop across one country to another.

TABLE B. ANALYSIS OF SUBJECTS ENTERING INTO FOREIGN AERONAUTICS

The formation of Industrial Links Coordinating Technical Societies	Post Office Reciprocity	Post War Inter Governmental Agreements (Allied and enemy)	Registration of Craft.	Customs and Policing. Quarantine and Aliens Question
	(a) Prices for postage. (b) Methods of collection and delivery. (c) Agreed routes.	(a) Flying rights. (b) Landing rights. (c) Rule of the "road". (d) Supply of aircraft to foreign governments. (e) International law prohibited areas, etc.	(a) Salvage by ships and by aircraft. (b) Exchange of meteorological news.	

In this tangle of difficulties there is a plan suitable for the first few years which has certainly the merit of simplicity, though probably no other, namely, that all air-borne goods should be free of duty, treating whatever advantages thereby accrued to the aerial transport companies as subvention in aid.

In the contrary event of a decision to levy duty on air-borne goods, we must consider the suggestion of a Customs police mounted on fast aircraft to pursue and watch traders. There are many difficulties about doing this, they are probably even greater than those involved in a civil aerial police that we probably must have.

For customs purposes it would be an anachronism to shoot down a suspected smuggler at sight, we cannot board an airplane in flight, nor can we know whether he is carrying sufficient hours' fuel to be capable of out distancing our policemen moreover, his chance of giving his pursuer the slip by using the shelter of clouds and darkness is considerable.

At first, at any rate, it may be best to accept air-borne goods untaxed. The class of substances carried will only be those at light weight, or of high value for weight, and of these mostly the ones which derive some advantage from rapid transit.

We should, of course, be envisaging the issue of an indirect subsidy of an amount not easily knowable, but, on the other hand, we should economize on what promises to be abnormally heavy costs in collecting the duties imposed. The competition with taxed sea-borne or land-borne goods would not perhaps be very serious if we remember the greater cost both of transport and insurance of air.

As to the importation of foreign aircraft themselves, this is more easily controlled because it involves alighting. It has been suggested previously that no preferential landing charges be made against foreign trader aircraft under certain circumstances of reciprocity, and accordingly an interval of stay in a country in excess of some preordained period might constitute importation for taxation purposes or alternately the Gordian knot might be cut, and preferential encouragement given to our own aircraft (as war necessaries) on the base of a bounty to airplanes built in the country, and so avoid attempting the alternative of a tax on imported foreign airplanes.

Winter Meetings of the S. A. E.

The Society of Automotive Engineers will hold its annual dinner at the Hotel Biltmore, New York, on Jan. 10, and a special war dinner will be held at the Hotel La Salle, Chicago, on Feb. 1.

International Aircraft Standards

(Continued from last issue)

387—Specifications for Alloy Steel Bars and Billets

(200,000 Lb. Per Sq. In. Tensile Strength)

GENERAL.—1 The general specifications 1G1, shall form, according to their applicability, a part of these specifications.

USE.—2 This steel is to be used for gears.

MATERIAL.—3 The material for these bars shall be chosen from among the I A S B standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.50 per cent; phosphorus, not over 0.03 per cent; sulphur, not over 0.03 per cent.

MANUFACTURE.—4 (a) The steel shall be manufactured or at least finished by the electric furnace or crucible process.

(b) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(c) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

Heat Treatment.—(d) The steel manufacturer shall state the heat treatment recommended to give the physical properties specified.

(e) If the bars are furnished in the heat treated condition and the mechanical tests show that the heat treatment has not been correct, the bars may be re-treated at the option of the purchaser.

WORKMANSHIP AND FINISH.—5 (a) The bars are to be sound, commercially straight, free from pipes, laps, twists, seams and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(b) Any article may be rejected because of injurious defects or faults in manufacture at any time notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—6 (a) The bars shall have the following physical properties:

Tensile Test.—(b) Minimum tensile strength 200,000 lb. per sq. in. (140.60 kg./mm²); minimum yield point, 100,000 lb. per sq. in. (112.48 kg./mm²); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 10 per cent; minimum reduction of area 35 per cent.

Impact Test.—(c) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact of rupture in foot pounds (or in kilogram meters). Results markedly lower than the average of this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

SELECTION OF TEST SPECIMENS.—7 Three bars of each size rolled from a heat shall be taken, and test pieces prepared in accordance with I A S B standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final test fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

DIMENSIONS AND TOLERANCES.—8 The dimensions and tolerances shall be those given by the specifications 3S11.

DELIVERY, PACKING AND SHIPPING.—9 (a) The bars may be delivered in the annealed or in the heat treated condition.

(b) The steel manufacturer must stamp the heat number and the I A S B steel serial numbers on each bar of material furnished for this specification where the bars are not less than 1½ sq. in. (968 sq. mm.) in cross section.

(c) Where bars are less than 1½ sq. in. (968 sq. mm.) in cross section and are not stamped with the heat and serial numbers, they shall be bundled into lots of not more than 150 lb. (68 kg.) per bundle and the heat number and the I A S B steel serial numbers must be stamped on a metal tag attached to each of the bundles.

Chemical composition of standard alloy steels

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
2335	0.30-0.40	0.50-0.80	0.040	0.045	3.25-3.75	

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Nickel	Chromium
3140	0.35-0.45	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3240	.35-.45	.30-.60	.040	.045	1.50-2.00	.90-1.25
X3340	.35-.45	.45-.75	.040	.045	2.75-3.25	.70-.95
3330	.25-.35	.30-.60	.040	.045	3.25-3.75	1.25-1.75
3340	.35-.45	.30-.60	.040	.045	3.25-3.75	1.25-1.75
X3440	.35-.45	.30-.60	.040	.045	4.00-5.00	1.00-1.50

CHROMIUM VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum	Chromium	Vanadium, minimum
6140	0.35-0.45	0.50-0.80	0.040	0.045	0.80-1.10	0.15

388—Specifications for Alloy Steel Bars and Billets

(225,000 Lb. Per Sq. In. Tensile Strength)

GENERAL.—1 The general specifications 1G1, shall form, according to their applicability, a part of these specifications.

USE.—2 This steel is to be used for gears.

MATERIAL.—3 The material for these bars shall be chosen from among the I A S B standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, and is further limited as follows: Carbon, not over 0.50 per cent; phosphorus, not over 0.03 per cent; sulphur, not over 0.03 per cent.

taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—6 (a) The bars shall have the following physical properties:

Tensile Test.—(b) Minimum tensile strength 225,000 lb. per sq. in. (158.18 kg./mm²), minimum yield point 180,000 lb. per sq. in. (126.54 kg./mm²); minimum elongation in 2 in. (50.8 mm.) or proportional gage length, 9 per cent; minimum reduction of area, 30 per cent.

Impact Test.—(c) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or in kilogram-meters). Results markedly lower than

the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

SELECTION OF TEST SPECIMENS.—7 Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with I A S B standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final test fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

DIMENSIONS AND TOLERANCES.—8 The dimensions and tolerances shall be those given by the specifications 3S11.

DELIVERY, PACKING AND SHIPPING.—9 (a) The bars may be delivered in the annealed or in the heat treated condition.

(b) The steel manufacturer must stamp the heat number and the I A S B steel serial numbers on each bar of material furnished for this specification where the bars are not less than 1½ sq. in. (968 sq. mm.) in cross section.

(c) Where bars are less than 1½ sq. in. (968 sq. mm.) in cross section and are not stamped with the heat and serial numbers, they shall be bundled into lots of not more than 150 lb. (68 kg.) per bundle and the heat number and the I A S B steel serial numbers must be stamped on a metal tag attached to each of the bundles.

Chemical composition of standard alloy steels

NICKEL STEELS.

Number	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel	Chromium
2335	0.30-0.40	0.50-0.80	0.040	0.045	3.25-3.75	

NICKEL-CHROMIUM STEELS.

Number	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel	Chromium
3140	0.35-0.45	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3240	.35-.45	.30-.60	.040	.045	1.50-2.00	.90-1.25
X3340	.35-.45	.45-.75	.040	.045	2.75-3.25	.70-.95
3340	.35-.45	.30-.60	.040	.045	3.25-3.75	1.25-1.75
X3440	.35-.45	.30-.60	.040	.045	4.00-5.00	1.00-1.50

CHROMIUM VANADIUM STEELS

Number	Carbon.	Manganese	Phosphorus maximum	Sulphur maximum	Chromium	Vanadium minimum.
6140	0.35-0.45	0.50-0.80	0.040	0.045	0.80-1.10	0.15

381—Specifications for Gun-Metal Castings

GENERAL.—1 The general specifications 1G1 shall form, according to their applicability a part of these specifications.

MATERIAL.—2 The chemical composition shall be as follows: Copper 87 to 89 per cent; tin, 9 to 11 per cent; zinc, 1 to 3 per cent; iron, 0.2 per cent maximum; lead, 0.2 per cent maximum.

MANUFACTURE.—3. (a) The material must be made from lake or electrolytic copper according to the I A S B specification 2N2 and pig tin having a purity of at least 99 per cent.

(b) No scrap shall be used, except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

WORKMANSHIP AND FINISH.—4 Castings must be homogeneous and free from shrinkage cracks, spongy spots, blow holes and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

PHYSICAL PROPERTIES AND TESTS.—5 Gun-metal castings shall have the following physical properties: Minimum tensile strength, 30,000 lb. per sq. in. (21.09 kg./mm²); minimum yield point 15,000 lb. per sq. in. (10.55 kg./mm²); minimum elongation, 15 per cent in 2 in. (50.8 mm.).

SELECTION OF TEST SPECIMENS.—6 (a) The test bars shall be cast to size either from the casting, if the size of the same will permit, or from a separate block. The test bar shall be connected with the casting or block by a ⅛ in. (3.18 mm.) gate running the entire length of the test bar.

(b) The total length of the test bar shall be at least 6 in. (152.4 mm.), the length between shoulders 2¾ in. (69.85 mm.); the diameter of the reduced section approximately 0.57 in. (14.48 mm.) for a length of 2¼ in. (57.15 mm.).

(c) This test bar when detached from the casting shall be machined according to the I A S B standard test bar 0.505 in. (12.83 mm.) in diameter.

(d) The test bars and casting shall have the heat number cast or stamped on the pieces.

(e) At least two test bars shall be cast from each heat.

(f) One test shall be made to represent each heat, but in case of a flaw in the test bar or a break outside of the middle third of the gage length, further tests may be made on extra test pieces as provided for in the foregoing paragraph.

DIMENSIONS AND TOLERANCES.—7 All castings must be true to pattern with correctly placed cores.

389—Specifications for Alloy Steel Bars and Billets for Case Hardening

(165,000 Lb. Per Sq. In. Tensile Strength)

GENERAL.—1 The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The material for these bars shall be chosen from among the I A S B standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor, it is further limited as follows: Carbon, not over 0.25 per cent.

MANUFACTURE.—3. (a) The steel shall be manufactured or at least finished by the open-hearth, electric furnace, or crucible process.

(b) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(c) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(d) The steel manufacturer shall state the heat treatment recommended for case hardening this steel and to give the physical properties specified.

WORKMANSHIP AND FINISH.—4. (a) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(b) Any article may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously passed the physical and chemical tests; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5 The bars shall have the following physical properties:

Tensile Test.—(a) Minimum tensile strength, 165,000 lb. per sq. in. (116.00 kg./mm²); minimum yield point, 150,000 lb. per sq. in. (105.45 kg./mm²); minimum elongation in 2 in. (50.8 mm.) or proportional gage length 14 per cent.

Hardness Test.—(b) After carbonizing, hardening and tempering, the case must show a minimum Shore scleroscope hardness number of 75.

Impact Test.—(c) When impact-testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot pounds (or kilogram meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

SELECTION OF TEST SPECIMENS.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I A S B standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

DIMENSIONS AND TOLERANCES.—7 The dimensions and tolerances shall be those of the specifications 3S11.

DELIVERY, PACKING AND SHIPPING.—8 (a) The bars shall be delivered in the annealed state.

(b) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.), unless otherwise agreed between manufacturer and purchaser, the heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached

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in each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Hardness Test.—(b) After carbonizing, hardening, and tempering, the case must show a minimum Shore scleroscope hardness number of 75.

Chemical compositions of standard alloy steels

NICKEL STEELS

Number	Carbon	Manganese	Phosphorus maximum	Sulphur maximum	Nickel	Chromium
2315	0.10–0.20	0.30–0.60	0.040	0.045	3.25–3.75	
2320	.15–.25	.30–.90	.040	.045	3.25–3.75	

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus maximum	Sulphur maximum	Nickel	Chromium
3120	0.15–0.25	0.30–0.90	0.040	0.045	1.00–1.50	0.45–0.75
3215	.10–.20	.30–.60	.040	.045	1.50–2.00	.90–1.25
X3315	.10–.20	.30–.60	.040	.045	2.75–3.25	.70–.95
3315	.10–.20	.30–.60	.040	.045	3.25–3.75	1.25–1.75

CHROMIUM VANADIUM STEELS

Number	Carbon	Manganese	Phosphorus maximum	Sulphur maximum	Chromium	Vanadium minimum
6120	0.15–0.25	0.30–0.60	0.040	0.045	0.60–0.90	0.15

When electric or crucible furnace steel is specified, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3S10—Specifications for Alloy Steel Bars and Billets for Case-Hardening

(180 000 Lb. Per Sq. In. Tensile Strength)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor. It is further limited as follows: Carbon not over 0.20 per cent.

MANUFACTURE.—3. (a) The steel shall be manufactured or at least finished by the open hearth, electric furnace or crucible process.

(b) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(c) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(d) The steel manufacturer shall state the heat treatment recommended for case-hardening this steel and to give the physical properties specified.

WORKMANSHIP AND FINISH.—4. (a) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and damaged ends and are to have a workmanlike finish. They are to be uniform in quality within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(b) Any article may be rejected because of injurious defects or faults in manufacture at any time notwithstanding that it has previously passed the physical and chemical tests. It shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. The bars shall have the following physical properties:

Tensile Test.—(a) Minimum tensile strength, 180,000 pounds per square inch (126.54 kg./mm.²), minimum yield point, 170,000 lb. per sq. in. (119.51 kg./mm.²), minimum elongation in 2 in. (50.8 mm.) or proportioned gage length, 12 per cent.

Impact Test.—(c) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot pounds (or kilogram meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

SELECTION OF TEST SPECIMENS.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser, the steel manufacturer may recommend a different heat treatment for the second set of test specimens, and to that end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

DIMENSIONS AND TOLERANCES.—7. The dimensions and tolerances shall be those of the specifications 3S11.

DELIVERY, PACKING AND SHIPPING.—8. (a) The bars shall be delivered in the annealed state.

(b) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.) unless otherwise agreed upon between manufacturer and purchaser. The heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Chemical compositions of standard alloy steels

NICKEL-CHROMIUM STEELS

Number	Carbon	Manganese	Phosphorus maximum	Sulphur maximum	Nickel	Chromium
X3315	0.10–0.20	0.30–0.90	0.040	0.045	2.75–3.25	0.70–0.95
3315	.10–.20	.30–.60	.040	.045	3.25–3.75	1.25–1.75

When electric or crucible furnace steel is specified, the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser, be limited to 0.03 per cent.

3N5—Specifications for Naval Brass or Equivalent Alloy Sheet

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. (a) The chemical composition of the brass shall be as follows:

	Per cent.
Copper	59 to 62
Tin	0.50 to 1.00
Iron maximum	0.10
Lead maximum	0.1
Zinc	Remainder

(b) Samples for analysis shall be taken by boring completely through the plate at various points across both ends.

MANUFACTURE.—3. (a) The material must be made from lake or electrolytic copper according to I. A. S. B. specifications 2N2 and virgin spelter of A or B grade according to I. A. S. B. specifications 2N3.

(b) No scrap shall be used except such as may accumulate at the manufacturer's plants from material of the same composition and of their own make.

WORKMANSHIP AND FINISH.—4. The material shall be free from all injurious defects. It shall be clean, straight, smooth, shall lie flat and shall be of uniform color, quality and size.

PHYSICAL PROPERTIES AND TESTS.—5. (a) The sheets shall show the following physical properties:

Tensile test.—(a) Plates less than ½ in. (12.7 mm.) thick and less than 30 in. (762 mm.) wide shall have a minimum tensile strength of 56,000 lb. per sq. in. (39.37 kg./mm.²), minimum yield point of 28,000 lb. per sq. in. (19.68 kg./mm.²), minimum elongation of 30 per cent in 2 in. (50.8 mm.). Over ½ in. (12.7 mm.) thick minimum tensile strength of 56,000 lb. per sq. in. (39.37 kg./mm.²), minimum yield point of 27,000 lb. per sq. in. (18.98 kg./mm.²), minimum elongation of 35 per cent in 2 in. (50.8 mm.), less than ½ in. (12.7 mm.) thick and over 30 in. (762 mm.) wide, minimum tensile strength of 54,000 lb. per sq. in. (37.96 kg./mm.²), minimum yield point of 27,000 lb. per sq. in. (18.98 kg./mm.²), minimum elongation of 35 per cent in 2 in. (50.8 mm.).

Bending test.—(b) Strips cut from plates shall stand being bent cold through an angle of 180 deg. in any direction to a radius equal to the thickness of the plate without fracture.

SELECTION OF TEST SPECIMENS.—6. One tensile-test specimen and one bending test specimen shall be taken for each lot of 500 lb. (226.8 kg.) or fraction thereof. If any test specimen breaks outside of the middle third of the gage length a retest will be allowed.

DIMENSIONS AND TOLERANCES.—7. (a) The weight or thickness shall not vary more than 7 per cent from that specified. Thickness will be specified in decimals of an inch or millimeter and shall correspond to the ordinary gage numbers.

(b) For wide sheets or plates above 48

in. (1219 mm.) to and including 60 in. (1524 mm.) a tolerance of 5 per cent over or 7 per cent under gage or weight will be allowed.

(c) For extra wide sheets or plates above 60 in. (1524 mm.) in width the tolerance may be 5 per cent over or 8 per cent under gage or weight.

(d) For the purpose of calculating weights, etc., the specific gravity of the alloy shall be taken as 8.404 at 20 deg. C., or 0.3036 lb. per cu. in. (8.404 grams/cm.³).

DELIVERY, PACKING, AND SHIPPING.—8. (a) Plates and sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(b) The following will be considered stock lengths for naval brass sheets when ordered in 10 ft. (3048 mm.) lengths, 40 per cent in weight may be in 8 to 10 ft. lengths (2438 to 3048 mm.); 30 per cent in weight may be in 6 to 8 ft. lengths (1829 to 2438 mm.); 20 per cent in weight may be in 4 to 6 ft. lengths (1219 to 1829 mm.); 10 per cent in weight may be in 2 to 4 ft. lengths (610 to 1219 mm.).

(c) No lengths less than 2 ft. (610 mm.) will be accepted and the total weight of all pieces in lengths less than 10 ft. (3048 mm.) must not exceed 40 per cent in any one shipment.

3S12—Specifications for High-Strength Steel Wire

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The wire shall be manufactured of either I. A. S. B. standard steel No. 1065, No. 1070, or No. 1080, the compositions of which are listed below.

MANUFACTURE.—3. The steel used shall be manufactured by the acid open hearth process. Every reasonable precaution shall be taken to keep different heats carefully separated and identified throughout the rolling and drawing of the wire and to the final stage of inspection and shipment.

(b) It shall be uniformly coated with pure tin to solder readily.

WORKMANSHIP AND FINISH.—4. The wire shall be cylindrical and smooth and may show no evidence of scrapes, splints, cold shuts, rough finding or other defects not in accordance with best commercial practice.

PHYSICAL PROPERTIES AND TESTS.—*Tensile Test.*—5. (a) Samples for the tensile test shall be not less than 15 in. (381 mm.) long and free from bend and kinks. In making tensile tests on aircraft wire the distance between jaws of testing machine, with the sample in place and before test, shall be 10 in. (254 mm.). The wire must not break at less than the amount specified in the attached table, which is a part of this specification.

Torsion Test.—(b) Samples for the torsion test shall be straight and not less than 10 in. (254 mm.) long. The sample shall be gripped in two vises 8 in. (203.2 mm.) apart; one vise shall be turned uniformly at a speed not exceeding 60 revolutions per minute (on the larger sizes of wire this speed shall be reduced sufficiently to avoid undue heating of the wire). One vise shall have free axial movement in either direction. All wire shall be required to withstand the minimum number of complete turns shown in the attached table, and which are calculated from the relation:

$$\text{Number of turns} = \frac{2.7}{\text{diameter in inches}} \quad \text{or} \quad \frac{68.6}{\text{diameter in millimeters}}$$

Bend Test.—(c) Samples for bend test shall be straight and not less than 10 in. (254 mm.) long. One end of the sample shall be clamped between jaws having their upper edges rounded with 3/16 (0.188) in. (4.76 mm.) radius. The free end of the wire shall be held loosely between two guides and bent 90 deg. over one jaw; this is to be counted as one bend. On raising to a vertical position the count will be two bends. Wire shall then be bent to the other side and so forth, alternating to fracture. The minimum number of bends required is stated in the attached table.

Wrapping Test.—(d) A wrapping test is to be made on at least 10 per cent of the total number of coils offered for inspection at one time. The wire is wrapped around its own diameter eight consecutive turns with a pitch substantially equal to the diameter of the wire and then unwrapped maintaining the free end at approximately 90 deg. with the mandrel. It must stand this test without fracture. Because of the possibility of personal error in making this test, failure on one test is not considered conclusive and if required to do so the inspector shall make at least one but no more than two, additional tests on the sample of wire. If any of these tests are successful the material shall be passed as satisfactory in this respect.

SELECTION OF TEST SPECIMEN.—6. A tensile, a torsion and a bend test shall be made on each end of each piece of coil or wire. When an individual coil of wire is to be divided into smaller coils to meet special requirements it is sufficient to make one test on the original coil and to cut and seal the small coils in the presence of the inspector.

DIMENSIONS AND TOLERANCES.—7. (a) All wire for this purpose shall be furnished in decimal sizes corresponding to the American Wire Gage (Brown & Sharpe gage).

(b) A permissible variation of 0.002 in. (0.051 mm.) above gage on all sizes will be accepted, but no wire will be accepted having a variation of more than 0.0005 in. (0.013 mm.) below gage.

DELIVERY, PACKING AND SHIPPING.—8. (a) Wire covered by this specification shall be shipped in coils or bundles wrapped closely with a layer of plain strong paper in strips no less than 3 in. (76.2 mm.) wide and then covered with another wrapping of waterproof paper of an approved quality.

(b) The size and weight of packages or coils shall conform to the following unless otherwise specified on orders: 0.072 in. (1.828 mm.) and larger, mean diameter of coils 22 in. (559 mm.), minimum weight of coil 25 lb. (11.34 kg.); 0.064 in. (1.628 mm.) and smaller, mean diameter of coils 12 in. (305 mm.), minimum weight of coil 10 lb. (4.54 kg.).

INSPECTION AND REJECTION.—9. A tag supplied by the manufacturer and filled in by the Government inspector with ink showing the number of the test as per his official list of tests, the diameter of the wire, the breaking strength, and torsion and bend tests shall be attached to each coil or piece of wire accepted by him or by the salvage board. Such tag shall be sealed on the bundle with a steel wire of approved design and a lead seal bearing the private mark of the inspector doing the work.

Chemical composition of standard carbon steels

Number	Carbon	Manganese	Phosphorus, maximum	Sulphur, maximum
1065	0.60–0.70	0.50–0.70	0.040	0.045
1070	.65–.75	.50–.70	.040	.045
1080	.75–.90	.25–.50	.040	.045

Table of physical properties, weights and sizes

ENGLISH UNITS

American Wire Gage	Diameter in inches	Minimum torsion in 8 in.	Weight in pounds per 100 ft.	Number of bends through 90 deg.	Breaking strength, minimum lbs.	Tensile strength in pounds per sq. in.
6	0.162	18	7.01	5	4,500	219,000
7	.144	19	[illegible]	8	3,700	229,000
8	.129	21	4.40	8	3,000	233,000
9	.114	23	3.50	9	2,500	244,000
10	.102	26	2.77	11	2,000	244,000
11	.091	30	2.20	14	1,620	254,000
12	.081	33	1.744	17	1,300	252,000
13	.072	37	1.383	21	1,040	255,000
14	.064	42	1.097	25	830	258,000
15	.057	47	.870	29	660	259,000
16	.051	52	.690	34	540	264,000
17	.045	60	.547	42	425	267,000
18	.040	67	.434	52	340	270,000
19	.036	75	.344	70	280	275,000
20	.032	85	.273	85	225	280,000
21	.028	95	.216	105	175	284,000

METRIC UNITS

American Wire Gage	Diameter in millimeters	Minimum torsion in 203.2 mm.	Weight in kilograms per 100 m.	Number of bends through 90 deg.	Breaking strength minimum kilograms	Tensile strength, in kilograms per square millimeter
6	4.115	18	10.44	5	2,041	154.0
7	3.665	19	8.28	8	1,678	161.0
8	3.264	21	6.55	8	1,361	163.8
9	2.906	23	5.21	9	1,134	171.6
10	2.588	26	4.12	11	907	171.6
11	2.305	30	3.28	14	735	178.6
12	2.053	33	2.597	17	590	177.2
13	1.828	37	2.060	21	472	179.4
14	1.628	42	1.635	25	378.5	181.8
15	1.450	47	1.295	29	297.8	182.1
16	1.291	53	1.028	34	244.9	185.6
17	1.150	60	.814	42	192.8	187.7
18	1.024	67	.646	52	152.4	189.8
19	.9118	75	.512	70	127.0	193.4
20	.8118	85	.406	85	102.0	196.8
21	.7230	95	.322	105	79.4	199.8

2N2—Specifications for Ingot Copper

GENERAL—1 The general specifications, 161 shall form, according to their applicability, a part of these specifications.

MATERIAL—2 (a) Copper may be either lake copper originating on the northern peninsula of Michigan U. S. A., or it may be electrically refined copper.

Analysis—(b) The copper in all shapes shall have a purity of at least 99.880 per cent as determined by electrolytic assay silver being counted as copper.

Sampling—(c) One bar, cake, billet, ingot or slab shall be taken for analysis from each lot of 5000 lb. (2,268 kg.) or less, but not more than 10 bars, cakes, billets, ingots or slabs need be taken from a carload.

IDENTIFICATION AND MARKING—3. All wire bars, cakes, slabs and billets shall be stamped with the maker's brand and furnace charge mark. Ingots and ingot bars shall have a brand stamped or cast in but need have no furnace charge mark.

DELIVERY, PACKING, AND SHIPPING—4 The refiner shall arrange carloads or lots so that as far as possible each shall contain pieces from but one furnace charge in order to facilitate testing by the user.

References A. S. T. M. Specifications B5—13.

2N3—Specifications for Spelter

GENERAL—1 The general specifications 161, shall form, according to their applicability, a part of these specifications.

MATERIAL—2 (a) Under these specifications virgin spelter—that is spelter made from ore or similar raw material by a process of reduction and distillation or by electrolysis and not produced from reworked metal—is recognized in five grades as follows:

A	High Grade
B	Intermediate
C	Brass Special
D	Selected
E	Prime Western

Composition—(b)

A High Grade—The spelter shall not contain over

	Per cent
Lead	0.07
Iron	0.03
Cadmium	0.07

It shall be free from aluminum. The sum of the lead, iron, and cadmium shall not exceed 0.10 per cent.

B Intermediate—The spelter shall not contain over

	Per cent
Lead	0.20
Iron	0.03
Cadmium	0.50

It shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 0.50 per cent.

C Brass Special—The spelter shall not contain over

	Per cent
Lead	0.60
Iron	0.03
Cadmium	0.50

It shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 1.00 per cent.

D Selected—The spelter shall not contain over

	Per cent
Lead	0.80
Iron	0.04
Cadmium	0.75

It shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 1.25 per cent.

E Prime Western—The spelter shall not contain over

	Per cent
Lead	1.60
Iron	0.08

Sampling—(c) One slab shall be taken for analysis from each lot of 5000 lb. (2,268 kg.) or less, but not more than 10 slabs need be taken from a carload. Saw each slab completely across from the middle of one long side to the middle of the other and use the sawdust as the sample or drill three 9 mm. holes along one diagonal of each slab boring completely through and taking care to make fine drilling, the holes should be drilled as nearly as possible at the middle and halfway between either end and the middle of such diagonals. Go over the drillings or sawings with a powerful magnet to take out any iron which may have come from the drill or saw, and mix the sample thoroughly. The drill or saw must be thoroughly cleaned before use and no lubricant shall be used in either drilling or sawing.

IDENTIFICATION AND MARKINGS—3 A brand shall be cast in each slab by which the maker and grade can be identified.

References A. S. T. M. Specifications B6—14 revised.

3N2 Specifications for Manganese Bronze Castings

GENERAL—1 The general specifications 161 shall form according to their applicability a part of these specifications.

MATERIAL—2. The chemical composition shall be as follows: Copper, 56 to 60 per cent; zinc, 37 to 41 per cent. Hardening constituents (which may include tin, iron, manganese and aluminum) 3 per cent maximum; lead 0.15 per cent maximum.

MANUFACTURE—3 (a) The material must be made from lake or electrolytic copper according to the I. A. S. B. specification 2N2 and virgin spelter of A or B grade according to I. A. S. B. specification 2N3.

(b) No scrap shall be used except such as may accumulate in the manufacturer's plants from material of the same composition and of their own make.

WORKMANSHIP AND FINISH—4 Castings must be homogeneous and free from shrinkage cracks, spongy spots, blowholes and foreign matter. Any castings developing defects in machining must be replaced by the manufacturer. The full weight of material in the original casting must be returned by the purchaser for each replacement.

PHYSICAL PROPERTIES AND TESTS—5 Manganese bronze castings shall have the following physical properties. Minimum tensile strength, 70,000 pounds per sq. in. (49.21 kg./mm.²), minimum yield point 30,000 pounds per sq. in. (21.00 kg./mm.²), minimum elongation 15 per cent in 2 in. (50.8 mm.).

SELECTION OF TEST SPECIMEN—6. (a) The test bars shall be cast either on the casting, if the size will permit, or on the bottom of a 3-in. square test block sufficiently long to accommodate the test bar. Chills shall not be allowed in casting the test bar.

(b) The test bars and casting shall have the heat number cast or stamped on the pieces.

(c) At least two test bars shall be cast from each heat.

(d) One test shall be made to represent each heat but in case of a flaw in the test bar or a break outside of the middle third of the gage length further tests may be made on extra test pieces as provided for in the foregoing paragraph.

DIMENSIONS AND TOLERANCES—7 All castings must be true to pattern with correctly placed cores.

3N4—Specifications for Naval Brass or Equivalent Alloy Bars

GENERAL.—1 The general specifications 161 shall form, according to their applicability, a part of these specifications.

USE—2 The material required under this specification is intended primarily for airplane turnbuckle barrels.

MATERIAL—3 The chemical composition shall be as follows:

	Per cent
Copper	59 to 63
Tin	0.5 to 1.5
Iron maximum	0.10
Lead maximum	0.3
Zinc	Remainder

MANUFACTURE—4 (a) The material must be made from lake or electrolytic copper according to the I. A. S. B. specifications 2N2, and virgin spelter of A or B grade according to the I. A. S. B. specification 2N3.

(b) No scrap shall be used, except such as may accumulate at the manufacturer's plants from material of the same composition and of their own make.

WORKMANSHIP AND FINISH—5 All bars are to be sound straight, free from roaks, laps, cracks, twists, seams and damaged ends, and are to have a workmanlike finish.

PHYSICAL PROPERTIES AND TESTS *Tensile Test* 6 (a) Rods from ½ in. (12.7 mm.) to 1 in. (25.4 mm.) inclusive, shall have:

	Pounds per square inch.	Kilograms per square millimeter	Per cent
Minimum tensile strength	67,000	47.10	
Minimum yield point	45,000	31.64	
Elongation in 2 inches (50.8 mm.)			22
Reduction of area			4

Bending Test—(b) The rods shall stand being bent, cold, through an angle of 120 deg. and to a radius equal to the diameter of the rod without fracture.

Strain Test—(c) The rod shall stand an immersion in an aqueous solution containing 100 grams of mercurous nitrate and 13 cu. cm. of 1.42 specific gravity nitric acid per liter for 15 minutes without cracking.

SELECTION OF TEST SPECIMENS—7 (a) Bars shall be grouped into lots of not more than 50. Three test pieces, one for each of the above tests, will be cut from a bar selected by the inspector from each lot or fraction thereof.

(b) The bending test bar will be of full size.

(c) The strain test bar will be at least 12 in. (304.8 mm.) long, of full size and shall be taken without bending, springing, polishing, or any other preparation whatever. At least 9 in. (228.6 mm.) of the length of this bar shall be immersed in the solution.

DIMENSIONS AND TOLERANCES.—8. Rods shall not vary in diameter more than the following amounts: Up to and including ⅜ in. (9.53 mm.) plus or minus 0.0015 in. (0.038 mm.); from ⅜ in. (9.53 mm.) and including 1 in. (25.4 mm.) plus or minus 0.0030 in. (0.076 mm.).

DELIVERY, PACKING AND SHIPPING—9 (a) Rods and bars when ordered to exact length will be furnished in stock lengths unless it is specifically required that lengths be exact.

(b) Stock lengths will be as follows: When ordered in 12 ft. (3.66 m.) lengths no lengths less than 8 ft. (2.44 m.), when ordered in 10 ft. (3.05 m.) lengths, no lengths less than 8 ft. (2.44 m.), when ordered in 8 ft. (2.44 m.) lengths, no lengths less than 6 ft. (1.83 m.); when ordered 6-ft. (1.83 m.) lengths no lengths less than 4 ft. (1.22 m.).

(c) When ordered to the lengths given above the weight of lengths less than length ordered shall not exceed 40 per cent of any one shipment.

Digest of the Foreign Aeronautical Press

Aeronautics (London), Sept. 12, 1917

Aircraft Losses in August—The following are the official figures relative to aircraft losses in August.

German machines destroyed by British	129
German machines driven down by British	104
German machines destroyed by French	60
German machines driven down by French	22
German machines destroyed by Belgians	8
British machines missing	94
Allied machines claimed by Germany	168

In addition, a Zeppelin was destroyed in the North Sea off the coast of Jutland. It is to be noted that the French reports are incomplete, as on one day they claim the destruction of several German machines. Taking only definite figures, it appears that during August the Allies wholly destroyed at least 198 German machines on the Western front, while the enemy himself only claims to have accounted for 168 Allied airplanes.

Aeronautics (London), Sept. 19, 1917

The Direct Lift Machine. By H. F. Smalman-Smith.—Assuming that a direct lift machine is today not merely mechanically possible, but capable of production in practical form, one may embody in brief some general idea of what would constitute a practical helicopter.

It would possess the ability to rise vertically from the ground and to descend thereto likewise. It must further be steerable and capable of horizontal motion at a moderate speed, at least. Its climbing capacity must equal or exceed that of the airplane, likewise, its ability to carry weight. Finally, it must include some reliable means of gliding down in safety in case of engine failure.

Given such a machine, it would appear to possess the following leading advantages. (1) It could rise from or descend to level areas little larger than that included in its circumference, (2) it could remain poised over a particular spot. In other things it would seem to be markedly inferior to the airplane.

Its application and value from the military point of view appear to be several. A helicopter might be made to serve every purpose achieved by a kite balloon, while displaying the additional advantages of being independent of control from the ground, of being able to maneuver vertically or horizontally under its own power, and of presenting an infinitely smaller target. It would also require the services of a much smaller personnel and have the further advantage of being free from delays caused by inflation.

For patrol work its uses appear limited, although a helicopter might be employed as a night patrol machine in connection with the defense of cities or be used for reconnaissance work with armies operating in a rocky country where no airplane could rise or descend in safety.

In connection with naval operations, a helicopter might be used to advantage for observation purposes from aboard ship at times when the launching of a seaplane might be attended with considerable risk.

Flight (London), September 27, 1917

Musical Sound of Aircraft Engines.—Some observers of enemy aircraft raids have pointed out that Gotha airplanes "drone" on the note A flat, while British machines prefer E and F. In doing so they have overlooked an important point when suggesting that anyone with the sense of absolute pitch should have no difficulty in identifying hostile raiders by their sound.

The pitch of a sound depends on the number of vibrations reaching the ear in a given time, and the number varies according as to whether the source of the sound is moving toward or away from the listener. Given a Gotha flying at 100 m.p.h., its A flat could vary as much as a perfect fourth, which is more than the difference between it and the British machines' E and F.

If an express train sounds its whistle while approaching and passing through a station, the pitch of the whistle, though actually the same all the time, will appear to rise as the train comes into the station and fall as it passes out. In the first case the sound waves reach the ear more frequently, as the source is approaching, and in the second less frequently as the source is retreating. It would be the same with Gotha's A flat, if it is always that note, whatever the speed of the machine, which is highly improbable.

Flight (London), October 4, 1917

Germany and the Air.—At a recent meeting of the German Aerial League, the treasurer, Lieutenant Bothe, made a report which appears to represent quite accurately the views and beliefs of that very large section of the German people which thinks ahead and is convinced that air power will decide the future of empires.

He first gave a very clear and comprehensive survey of the present position of aeronautics in Germany, claiming that the Germans had now really obtained the supremacy of the air on the Western Front as on other fronts, though he had to

ALBATROS D III FIGHTERS

Pictorial Press *British Official Photograph*

acknowledge that at the time of the great Somme offensive the mastery in the air belonged to the British and French.

This led to a reawakening in German military circles and to a redoubling of their efforts to regain that supremacy, and no stones were left unturned until that object had been successfully attained.

The Germans had now left their adversaries far behind, both in the number and quality of the aircraft being turned out, as the English were learning to their cost.

Lieutenant Bothe then dealt at some length with the position of military aeronautics after the present war. He foretold that on the cessation of the present hostilities all the nations would at once proceed to build up an impenetrable series of modern defensive works, extending several miles behind their frontiers, and which it would be beyond the power of human beings to break through, except by the aerial arm.

In future wars it would be necessary to invade the enemy's territories by means of tens of thousands of airplanes, which by dropping hundreds of tons of explosives would destroy all industrial works, transport routes, etc., and thus delay the advance of the troops and impede preparations for offence or defence.

The war would be won within the first few days of the declaration of hostilities by the Power or Powers which were thus able to throw in the largest weight of aerial "frightfulness" and thereby paralyze the fighting efficiency of its opponents, before even a battle had been fought or a campaign opened.

Where, it may be asked, are to be found the pilots to man these tens of thousands of airplanes? This would be one of the chief duties of the German Aerial League, an institution which was daily growing in importance and influence.

By suitable courses of training at airdromes and in the workshops, the youth of the country would be prepared for later service in the Flying Corps.

Air Raid Precautions—The Police Commissioner of London has issued, for the guidance of the public, a set of rules to be observed in case of a hostile aircraft raid In view of the possibility of Germany developing submersible seaplane carriers from which American shores might be bombed, it seems interesting to review here these rules

Do not pay heed to mere rumors of a raid, but as soon as you know, whether from a public warning or from the anti aircraft guns coming into action, or from the explosion of bombs, that an attack is imminent or has begun, take the best cover near at hand

Do not wait till you see the aircraft nearly overhead or hear the explosion of a bomb near you You cannot tell how near the next bomb may fall, especially at night, and apart from the danger from bombs, fragments of shells may fall a long way from the guns To stay in the open involves needless risk, even if the attack seems a long way off

If you are in the open, go into the nearest available building A doorway or open archway, though better than remaining in the open, is not good cover, as it affords little protection against fragments of a bomb exploding on the ground

If bombs are being dropped and there is no building near, it is better to lie down on the ground in the best ditch or hole you can find near at hand, or behind a strong wall or tree than to remain standing in the open

If you are in a building on the top floor, go downstairs, where you will have the best available cover overhead, avoiding elevator openings, open stairways and parts of the building under skylights.

Do not look out of windows, but keep in a part of a room or passage where you will be out of the line of fragments of metal or debris, which may enter by a window or door if a bomb should explode outside

Do not crowd in a basement with only a single means of exit The fumes from all bombs are injurious if breathed in any quantity, and it is advisable to have a second means of exit in case fumes should enter, or a gas pipe be broken, or rapid escape be necessary for any other reason

Water is far the best extinguisher for general use against fires caused by incendiary bombs, and should be applied as promptly as possible Keep a supply of water ready in buckets or cans, some on each floor, if possible See that they are kept filled

A supply of fine dry sand or soil may be kept ready in pails or scuttles, in addition to water, especially where there are inflammable liquids which might be set alight See that the sand or soil does not cake

If the gas is turned off at the meter, see that all burners are turned off as well, otherwise there will be serious risk of fire or explosion when the gas is turned on again

Be careful not to breathe fumes given off by bombs. Do not go near where any bomb has fallen unless it is necessary to do so for rescue purposes or to extinguish a fire, or unless you are sure all fumes have cleared away

If a bomb falls near you, get away from the place where it has fallen as quickly as possible, and keep away until the air has cleared If you are indoors and fumes have entered the building, go out into the open away from where the bomb has fallen, and if the raid is not over, find other shelter

While good cover is the point of most importance, choose, if you can, rooms, corridors, etc, where in addition to cover overhead there are alternative means of exit, so that if fumes should enter from one direction you may be able to escape the other way

Flying (London), September 26, 1917

Aero Engine Fuels—The ideal fuel for internal combustion engines would be one having an entirely homogeneous composition with a constant boiling point and unvarying density at that boiling point, but gasoline does not attain this perfection, for when subjected to a gradual increasing temperature the fuel steadily loses in volume and increases in specific gravity until the temperature corresponding to the boiling point of its heaviest part is attained when it is completely evaporated

The supply of gasoline has now assumed a position of great importance in all countries. It is essential for the commercial future of the airplane that there shall be a plentiful supply of this fuel at reasonable prices, and it is generally recognized that the enormously increased demand can only be met by either a greater production or by increasing the specific gravity of the gasoline in order to obtain a greater proportion from the crude oils when refining. It is quite possible that by the latter method double the present available supply may be obtained if the maximum boiling point of the fuel can be increased to over 200 deg, but this can only follow such improvements in the design of aero engines as will allow a heavy fuel being used It is doubtful whether the production of the present grades of gasoline from existing or new wells can be increased to an appreciable extent, and it has been suggested that this supply can be augmented by condensing the natural gas obtained at the oil fields. It has, however, been shown that even if this were done in all parts of the world the total yield of gasoline would only be about five per cent more

Various substitutes for gasoline have been proposed during the past few years, and probably benzol is the best known of these, as before the war it was becoming extensively used for motor-cars

Benzol is not a definite compound, as it is a mixture of the hydro-carbons benzine, toluene, and xylene, each of which can be obtained pure, so that the commercial fuel is more homogeneous than ordinary gasoline The specific gravity of crude benzol is approximately 0.9 and that of the commercial fuel supplied for engines about 0 88

Benzol is a very inflammable oil, and the vaporization point occurs just a little later than that of the heavier grades of gasoline, but its range is much narrower, also from comparative tests with this fuel and gasoline with motor-cars it has been found that an increased mileage is obtained per gallon, although the calorific value of benzol is only 17,250 British thermal units per pound The greater density is due to the oil being rich in carbon and containing a lesser amount of hydrogen, and this high percentage of carbon makes it especially suitable for mixing with another gasoline substitute, alcohol, the resulting mixture forming a most suitable home-produced fuel for motor-cars and air engines which will ultimately be obtained in sufficient quantity to make the country independent of gasoline

A gasoline carburetor can be used in the ordinary way for carbureting air with benzol, but the carburetor jet has to be corrected in height or the float adjusted to allow the heavier fuel to stand at the correct level in the jet, and a slightly better supply of air is required owing to the fuel containing more carbon The grade of this fuel suitable for engines is usually known as "90 per cent Benzol," so called because this percentage will distil out at a temperature below the boiling point of water

Flying (London), October 17, 1917

Aeronautical Terminology—A representative committee of the Aeronautical Society of Great Britain is now taking in hand the putting into shape of the technical terminology of aeronautics. The work being of considerable magnitude, the full results of the labors of the committee will not appear for many months, but it is understood that certain preliminary definitions will be dealt with quickly in order to clear the ground and relieve existing anomalies that cause confusion (This work will undoubtedly prove a valuable addition to the elementary terminology the Aeronautical Society published shortly before the outbreak of the war The terms adopted therein are now used in most English and American text books —EDITOR)

Air Work in September—The accompanying comparative table shows the total number of airplanes and seaplanes brought or driven down on the Western front during the months

May
June
July
August
September

Out of the total for September, the Allies, according to German claims, lost 242 machines and the Germans lost [illegible] The detailed reports for September are

BRITISH REPORTS

Enemy machines brought down
Enemy machines driven down
British machines missing

FRENCH REPORTS

Enemy machines brought down
Enemy machines driven down
Enemy balloons brought down

GERMAN REPORTS

Allied machines brought down
German machines admittedly lost
Allied balloons brought down

News of the Fortnight

Aircraft Board Appointments

Naval and military members of the Aircraft Board, about to be reorganized under a law giving it legal status, were announced on Oct. 26 by Secretaries Daniels and Baker President Wilson is to name a civilian chairman and two other civilian members.

All of the service representatives appointed except Lieut Commander Arthur K Atkins, of the Navy, are members of the present board They are Navy, Rear Admiral David W Taylor and Capt H E Irwin, Army, Maj Gen George O Squier, Col E A Deeds and Col R L Montgomery.

Powerful Airplanes Are Planned

The day of thrilling air duels between individual aviators over the fighting lines in Europe appears to be passing. Both official and unofficial advices recently have shown increasing use of heavier machines with greater armament, and the development of air machines appears to be paralleling closely the development of fighting ships.

There are indications that amendment already has been necessary in the program for creating the huge air fleets provided for by Congress. While there will be no lack of small fighting airplanes, it is probable that stress is being laid now on the bombing craft and upon increasing the speed of these heavier machines and giving them adequate armament. Already plans are maturing for powerful airplanes, it is understood.

There have been rumors of great German aircraft soon to make their appearance, and officials believe that the Germans are impressed with the desirability of substituting heavier machines in which fighting power takes the place of speed.

The production of training machines, it is understood, is the only element of the aircraft program which is lagging behind schedule.

New supply sources for the training machines are shortly to begin deliveries. That will increase the output, and the first of the year probably will see the entire program abreast or ahead of its schedule. In the meantime there has been little delay in the training of aviators and many already have been sent abroad after preliminary instruction to get proper flying experience.

Orville Wright Honored

Orville Wright was honored on Oct 27 by Lord Northcliffe, head of the British War Commission to the United States, who decorated him with the Royal Albert Medal. The medal was presented by the Royal Society of the Arts of England, which awards a medal each year to some one prominent in the arts and sciences of the world.

New Balloon Altitude Record

According to the geographical institute at Pavia, Italy, the highest altitude so far reached by any balloon was 105,000 ft., or slightly over eighteen miles above sea level, and 104,082 ft. above actual ground. The balloon was of rubber and was filled with hydrogen gas.

The actual distance traversed measured 116,064 ft. At a height of 59,196 ft. the temperature fell to minus 43 deg. and maintained that figure all the balance of the way up, with only slight variation.

The aviator, Giacomo Peccolo, was compelled to utilize his oxygen inhalator after he reached the height of two miles, and reached ground in a collapsed condition nevertheless.

Prof. Pericles Gamba, in the Annali di Ufficio, states that the benefits to science from that ascent were incalculable, as it proved mainly two things: that the assumption of a fifteen mile atmosphere above the ground is erroneous, and that the theory of ether outside of that limit is not admissible, "as it does not altogether do away with the ether theory at any height." The word "ether" has been formed to express the medium for light beyond the assumed atmosphere.

This ascent established beyond peradventure that the medium is uniform after the height of about 50,000 ft. was reached. If the atmospheric consistency remains the same 55,000 ft. after that altitude, the assumption that it will remain the same further up reaches the dignity of a presumption.

To Make a Pictorial History of War

The Photograph Division of the Signal Corps has been formally designated as the bureau which will obtain the necessary photographs to form a pictorial history of the "War of 1917," as the present conflict is specifically termed in the orders relating to this new venture. The detail of commissioned officers and men to handle the photographic work is authorized from each division. These men will be attached to the Signal Corps units assigned to the army division. Regimental and separate organization commanders have been instructed to submit the names of men, qualified to fill the above positions, who desire to be transferred to the Signal Corps.

An Airplane Material Course

Training students as inspectors of airplane material is the latest war time addition to the curriculum of the Pennsylvania State College. Prof George R Green, of the Department of Forestry, has started a class of twenty men in wood technology. They will study the structure, strength and durability of spruce and ash, which are the chief woods used in airplane construction.

Pictorial Press NIEUPORT 1½ PLANE FIGHTER *French Official Photograph*

British Airplane Representative in America

Basil Bancroft
From Moody

Basil Bancroft, American representative of Whitehead Aircraft, Ltd., Richmond, Surrey, England, recently arrived in America with plans for cooperating with the American airplane manufacturers in the assembly of American machines in the Whitehead works.

Both Mr. Bancroft and J. A. Whitehead, governing director of the company are native Californians. Mr. Bancroft served in the British Army in France and has been honorably discharged because of wounds and shell shock.

Whitehead Aircraft, Ltd., is one of the largest British manufacturers, is capitalized at over $6,000,000.

They have been engaged exclusively in turning out and have nearly completed an additional plant for enlarged production of fighting machines for the British Government.

Airplane Engine Endurance Record

For the first time in the history of the aeronautical testing laboratory at the Washington Navy Yard an airplane engine has completed the Government endurance test. When it is considered that engines from all parts of the world have been tested at this laboratory previously, and that not a single one of them has run over 36 hr., the severity of the test is better appreciated.

As in the case of the two previous records, the new high mark has been set by an American-made engine—one built by a concern which has until recently been known only in the field of heavy duty marine engines. The experience gained in many years devoted to the design of engines, in which reliability and endurance were of the greatest importance has evidently had much to do with the success of this new engine.

The record run as it now stands is 54 hr., and was made by the Union engine. In fact, it was established by the same engine, which last May was put through a similar test by Government inspectors at San Francisco, a complete description of which was published in AVIATION AND AERONAUTICAL ENGINEERING, July 1, 1917.

Although details of the test are not now available for publication, it is understood that the engine was intentionally stopped after running 54 hr., owing to the blowing out of an oil pump gasket, which, due to consequent low oil pressure, made it unwise to continue the test, although the engine was otherwise in perfect condition and still delivering over its rated power.

The Caproni Machine Flies to Mineola

What is reported to be a new record in long distance passenger carrying flights was made Oct. 22 by Lieutenant Resnati, the Italian aviator who flew from Langley Field, Hampton, Va., to the U. S. Aviation Field at Mineola, N. Y., in a little over four hours. The Caproni biplane made the 325 mile run without a mishap. It was preceded by a Pomilio biplane scout driven by Lieutenant Balbioli, who made the trip with one passenger in a little less than three hours.

The passengers in the Caproni were Capt. A. W. Hill, C. A. C.; Lieut. M. W. Pollack, who represented Maj. Gen. Geo. O. Squier, Chief Signal Officer of the Army; Capt. Guido Tappi of the Italian Aviation Commission; Lieut. A. Campori, Corp. J. Z. Angelo and Giovanni Basso and Francesco Callulli, mechanicians, and Lieut. James Erickson, the American photographer.

Wood Experts Sought

The War Department has asked the University of California to assist in selecting a number of experts in woods, according to an announcement made recently by university authorities. These experts will receive salaries ranging from $1,200 to $3,000 yearly, and must be skilled in the picking out of woods suitable for military airplanes.

More Aviator Cadets Wanted

Efforts are being made at the headquarters of the Eastern Department to speed up the rate of enlistments in the Aviation Section of the Signal Officers' Reserve Corps. Twenty thousand men are needed to man the great air fleet which the War Department intends to send to Europe. Although the Aviation Section attracts many applicants before the examining board each day, the physical and mental requirements are exacting and fully 50 per cent of the applicants received are rejected.

An official in charge of recruiting for the Aviation Section denies that candidates are subjected to any nerve-racking tests, as has been frequently reported. He says the examination is a scientific one, calculated solely to ascertain the applicant's physical condition and his powers of endurance. Absolutely perfect eyesight is required. In all other respects, however, the examination is one which any man can pass, provided he meets the requirements as to height and weight.

Candidates for commissions as flying officers in the Aviation Section must be at least nineteen years old and preferably not more than thirty, although in exceptional cases older men of pronounced athletic attainments, who have spent most of their lives out of doors, in the saddle, rambling, etc., may be accepted if they can satisfy the examining board of their physical fitness. Candidates for commissions must have college training or its equivalent. Applicants will not be recommended, who are not in every way qualified and fitted to become officers of the United States Army.

All candidates are enlisted in the Signal Corps or the Signal Enlisted Reserve Corps. This service will actually hold them for the period of training, which covers the course at the schools of military aeronautics (ground schools), and at the aviation or flying school up to the time when, having passed the tests for a reserve military aviator or junior military aviator as required by the Chief Signal Officer, they are commissioned. If they fail, they will be discharged from the Signal Corps and revert to their former status. Failure to qualify for a commission will not exempt from the draft law.

Army Wants Air Mechanics

The Aeronautical Office of the United States Army at 104 Broad Street, New York City, has made an appeal for recruits to go to France immediately as privates in the Aviation Section of the Signal Corps to maintain and repair airplanes.

Maj. Gen. George O. Squier, Chief Signal Officer of the United States Army, has directed that a recruiting campaign begin at once, with the object of enlisting a total of 100,000 men who will be employed chiefly at the hangars of American aviators in keeping flying equipment in shape. The men called for in this appeal are not to act as aviators, but will remain in barracks at the aviation fields which are occupied by Americans in France. Those who are first to enlist as privates in the Aviation Section will go to France.

Carpenters, electricians, mechanics, men familiar with gas engines, and others who know how to use their hands are asked to enlist at once.

British Aeronautical Material Agent

It is reported that Arthur F. Thane of A. F. Thane & Co., San Francisco, Cal., has been appointed purchasing agent for the British Government on the Coast for all lumber, aeronautical material and supplies, which will be drawn from that region for aircraft construction and equipment.

In addition to acting as purchasing agent, Mr. Thane will have charge of all shipping for the British Government on the Pacific Coast. For ten years he was connected with W. R. Grace & Co. of New York.

New Training Biplane

A new type of training biplane has been flown at Central Park, N. Y., by Army Instructor Acosta, in which the instructor and pilot sit side by side. This arrangement, it is believed, will shorten the time required for training aviators. The machine is the product of the Ordnance Engineering Co. and is powered with a 100 hp. Duesenberg engine.

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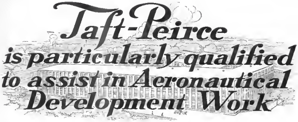

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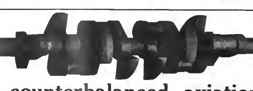

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